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Bass Lake Dam,
Florence, Montana,
Ravalli County,
MT-1176

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

BASS LAKE DAM
FLORENCE, MONTANA
RAVALLI COUNTY
MT-1176

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PREPARED FOR:

HONORABLE THOMAS L. JUDGE
GOVERNOR, STATE OF MONTANA

BASS LAKE RESERVOIR COMPANY
(OWNER)

PREPARED BY:
CH2M HILL
BELLEVUE, WASHINGTON

APRIL 1980

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EXECUTIVE SUMMARY

Under contract with the Seattle District Corps of Engineers, and with representation from the Corps, the State of Montana Department of Natural Resources and Conservation (DNRC), the U.S. Forest Service, and the Bass Lake Reservoir Company, CH2M HILL inspected Bass Lake Dam on July 19, 1979, under the authority of Public Law 92-367. The dam is located on Bass Creek, a tributary of the Bitterroot River, in Ravalli County, about 10 miles southwest of Florence and 11 miles northwest of Stevensville, Montana.

This report was compiled from information obtained during an onsite inspection, review of construction plans, and analysis of available hydrologic information. Findings were compared with engineering criteria that are currently accepted by most private and public agencies engaged in dam design, construction, and operation.

FINDINGS AND EVALUATION

Bass Lake Dam is owned and operated by the Bass Lake Reservoir Company. The dam and reservoir are located within the Selway-Bitterroot Wilderness area of the Bitterroot National Forest. Bass Lake is used for storage of irrigation waters and for recreation. Use of National Forest land for such purposes is through special use permits issued by the U.S. Forest Service.

The 43-foot-high earth dam impounds 3,900 acre-feet of water at assumed top of dam, elevation 6773.1 feet National Geodetic Vertical Datum (NGVD), previously Mean Sea Level (MSL). On the basis of criteria in U.S. Army Corps of Engineers Recommended Guidelines for Safety Inspection of Dams (Ref. 1), the project is intermediate in size. The dam is located such that its failure could endanger many lives. However, no dam breach analysis or routing of a dam breach flood was made for the downstream area. The conclusions on probable damage are based on a brief field visit and engineering judgment.

The project is classified as having a high (Category 1) downstream hazard potential. According to inspection criteria (Ref. 1), the recommended spillway design flood (SDF) for an intermediate-sized project with a high downstream hazard potential is the probable maximum flood (PMF). The PMF is the flood expected from the most severe combination of meteorologic and hydrologic conditions that are reasonably possible in the region.

A brief visual inspection of the dam embankment revealed no serious cracks, irregularities, or slumps. Minor erosion had taken place on the upstream face and along the right

abutment contact. Seepage, estimated at 500 gpm for the entire embankment, was flowing primarily from the left side of the embankment, on the downstream bench and the toe. The seepage is clear and probably has been flowing since construction of the dam in 1952. There is no information on how the embankment was actually constructed, or strength characteristics of embankment materials; therefore, stability cannot be evaluated.

An estimated PMF was developed for the 1.53-square-mile drainage basin. Refinement of this estimate may either increase or decrease the final flood characteristics. The estimated PMF resulting from the 6-hour thunderstorm has a volume of 720 acre-feet and a peak flow of 14,600 c.f.s. The spillway has a maximum discharge capacity of 400 c.f.s. with the reservoir at assumed top of dam, elevation 6773.1 feet NGVD. Routing of the estimated PMF was started with the reservoir at assumed spillway crest, elevation 6770 feet NGVD.

Routing indicates that:

a) During the full PMF the dam would be overtopped when approximately 45 percent of the flood volume had entered the reservoir, and

b) routings were made of lesser hypothetical floods than the PMF to determine the magnitude of floods the dam can contain. The hypothetical hydrographs are obtained by applying percentages to the PMF ordinates. A flood with a hydrograph having ordinates corresponding to one-half the PMF ordinates is just controlled by the project. Larger floods would overtop the dam.

The dam is constructed of materials that would quickly erode and rapidly fail when overtopped by floodwaters.

On the basis of the field inspection and preliminary hydrologic analysis, Bass Lake Dam does not now conform to inspection guidelines with respect to discharge and/or storage capacities to safely handle the PMF, leading to potential loss of life and property destruction.

The spillway discharges along the left abutment contact and sustained high flows could erode and fail the embankment. The outlet conduit is very rusty and may need to be replaced or fitted with a liner in the next few years. The log boom is located within the spillway approach channel and restricts spillway discharges.

RECOMMENDATIONS

Because of storage between normal pool and dam crest, the present project provides a degree of flood protection to the downstream area. The intent of the report recommendations is to maintain or improve project safety without decreasing this flood protection.

Develop a downstream warning plan, for use in the event of possible dam overtopping or structural failure, and immediately place it in operation. Provide adequate embankment protection along spillway discharge channel so high flows will not erode the embankment. Plan to repair the outlet conduit within the next few years. Reconstruct the log boom so it is not within the spillway approach channel. Conduct engineering studies to determine the detailed PMF and modify the discharge and/or storage capacity to safely handle the PMF. Investigate the observed seepage, determine the phreatic surface and investigate measures to reduce seepage and lower the phreatic surface. Conduct more detailed hydrologic and hydraulic routing studies to better determine the downstream hazard and required spillway capacity, and modify the project as studies indicate. Conduct periodic inspections of the project at intervals not to exceed 5 years by engineers experienced in dam design and construction.

MONTANA
RICHARD L.
FOSTER
2646 E
REGISTERED
PROFESSIONAL ENGINEER

Richard L. Foster
Professional Engineer

PERTINENT DATA

1. GENERAL

Federal ID No.	MT-1176
Owner	Bass Lake Reservoir Company
Operator	Bass Lake Reservoir Company
Date Constructed	1952-1953
Purpose	Irrigation and Recreation
Location	Section 30, T10N, R21W Principal Meridian
County, State	Ravalli County, Montana
Watershed	Bass Creek, tributary of Bitterroot River
Downstream Hazard Potential	Category 1 (High)
USGS Quadrangle	Saint Joseph Peak

2. RESERVOIR

Surface Area at Spillway Crest	96 acres
Drainage Area	1.53 square miles
Storage at Spillway Crest, Elevation 6770 ft NGVD	3,600 acre-feet
Storage at Dam Crest, Elevation 6773.1 ft NGVD	3,900 acre-feet
Surcharge Storage	300 acre-feet

3. SPILLWAY

Type	Uncontrolled, unlined chute
Bottom Width	27 feet
Crest Elevation	6770.0 feet NGVD (assumed)
Capacity with Reservoir at Dam Crest	400 c.f.s.

4. OUTLET WORKS

Conduit	Two 24-inch-diameter, corrugated steel pipes (CMP) leading to one 30-inch-diameter CMP

Conduit Length	220 feet
Gates	Two 24-inch-diameter sluice gates
Capacity with Reservoir at Dam Crest	80 c.f.s.

5. DAM

Type	Rolled earth and rockfill
Length	300 feet
Crest Width	33 feet
Crest Elevation	6773.1 feet NGVD (assumed)
Hydraulic Height (Crest to Toe)	43 feet
Upstream Slope	1 V on 3 H
Downstream Slope	1 V on 1.5 H (upper) to the 30-foot berm; 1 V on 2 H (lower); 1 V on 1 H at right abutment

Chapter 1
BACKGROUND

1.1 INTRODUCTION

1.1.1 Authority and Scope

This report summarizes the Phase I inspection and evaluation of the Bass Lake Dam, owned by the Bass Lake Reservoir Company.

The National Dam Inspection Act, Public Law 92-367, dated August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to conduct safety inspections of non-Federal dams throughout the United States. Pursuant to that authority, the Chief of Engineers issued "Recommended Guidelines for Safety Inspection of Dams" in Appendix D, Volume 1, of the U.S. Army Corps of Engineers' Report to the United States Congress on "National Program of Inspection of Dams" in May 1975.

The recommended guidelines were prepared with the help of engineers and scientists highly experienced in dam safety from many Federal and state agencies, professional engineering organizations and private engineering consulting firms.

Consequently, the evaluation criteria presented in the guidelines represent the comprehensive consensus of the engineering community.

Where necessary, the guidelines recommend a two-phased study procedure for investigation and evaluation of existing dam conditions, so deficiencies and hazardous conditions can be readily identified and corrected. The Phase I study is:

1. A limited investigation to assess the general safety condition of the dam.

2. Based upon an evaluation of the available data and a visual inspection.

3. Performed to determine if any needed emergency measures and/or if additional studies, investigations, and analyses are necessary or warranted.

4. Not intended to include extensive explorations, analysis, or to provide detailed alternative correction recommendations.

The Phase II investigation includes all additional studies necessary to evaluate the safety of the dam. Included in Phase II, as required, should be additional visual inspections, measurements, foundation exploration and testing,

material testing, hydraulic and hydrologic analyses, and structural stability analyses.

The authority for the Corps of Engineers to participate in the inspection of non-federally owned dams is limited to Phase I investigations with the exception of situations of extreme emergency. In these cases, the Corps may proceed with Phase II studies but only to the extent needed to answer serious questions relating to dam safety that cannot be answered otherwise. The two phases of investigations outlined above are intended only to evaluate project safety and do not encompass in scope the engineering required to perform design or corrective modification work. Recommendations contained in this report may be for either Phase II safety anlyses or detailed design study for corrective work.

The responsibility for implementation of these Phase I recommendations rests with the dam owner and the State of Montana. Prior to any action to implement report recommendations, the owner is urged to contact the State of Montana DNRC. It should be noted that nothing contained in the National Dam Inspection Act, and no action or failure to act under this Act shall be construed (1) to create liability in the United States or its officers or employees for the recovery of damage caused by such action or failure to act or (2) to relieve an owner or operator of a dam of the legal duties, obligations, or liabilities incident to the ownership or operation of the dam.

1.1.2 Purpose

The purpose of the inspection and evaluation is to identify conditions that threaten public safety, so that they may be corrected in a timely manner by non-Federal interests.

1.1.3 Inspection

The findings and recommendations in this report were based on a brief visual inspection of the project, and a detailed review of available construction plans. Inspection procedures and criteria were those established by the Recommended Guidelines for Safety Inspection of Dams (Ref. 1).

Personnel present during the July 19, 1979, inspection included:

Captain Don Warner, Corps of Engineers
Art Taylor, State of Montana Department of Natural Resources and Conservation
Alex Bailey, State of Montana Department of Natural Resources and Conservation
Ron Volden, U.S. Forest Service
Dale Thacker, U.S. Forest Service

Dick Judge, U.S. Forest Service
George Raffatto, Secretary, Bass Lake Reservoir Company

CH2M HILL personnel who participated in the field inspection and contributed to this report are:

Miles C. Bubenik, Geotechnical Engineer, Team Leader
Jerry Jacksha, Geotechnical Engineer
Loren Bottorff, Hydrologist/Hydraulics Engineer

This report has been reviewed by the State of Montana Department of Natural Resources and Conservation; the U.S. Forest Service; and the owners, Bass Lake Reservoir Company. Their comments are included in the Appendix. The Corps of Engineers response letter to Mr. Ruffatto is also included in the Appendix.

1.2 DESCRIPTION OF PROJECT

1.2.1 General

Bass Lake Dam is located on Bass Creek, in Ravalli County, Montana, approximately 10 miles southwest of Florence and 11 miles northwest of Stevensville (see Plate 1). The dam and reservoir are located within the Selway-Bitterroot Wilderness area of the Bitterroot National Forest.

The stream channel (Bass Creek) below the dam is confined in a narrow steep-walled canyon. A U.S. Forest Service campground is located along the stream near the mouth of the canyon, approximately 7.2 miles downstream of the dam. Approximately .8 miles farther downstream, the stream passes a developing subdivision of vacation homes.

Use of the lake for irrigation water storage is through a special use permit issued by the U.S. Forest Service. The National Dam Inventory for Montana lists Bass Lake Dam as having a high (Category 1) downstream hazard potential and the Federal identification number is MT-1176. The U.S. Forest Service also identifies Bass Lake Dam as a high hazard structure because of possible loss of life if failure occurs. According to information received from the U.S. Forest Service, the campground is used year-round, with heavy use beginning in June and continuing through the end of August. The Forest Service estimates a range of 400 to 800 visitors daily during the summer months and a maximum of 100 persons in the campground at any given time.

The 43-foot-high, 300-foot-long earth dam, constructed in 1952-1953, impounds 3,900 acre-feet at dam crest, assumed elevation 6773.1 feet NGVD. Based on visual reconnaissance and engineering judgment, the forest campground and several vacation homes could be affected by a sudden breach of the dam. On the basis of this information and in accordance with the recommended guidelines, the project size is intermediate and the downstream hazard potential is high.

The 96-acre reservoir is used for water supply and irrigation, but it does receive recreational use because of its location in the Selway-Bitterroot Wilderness area. The dam, reached by a 28-mile roundtrip on horseback, is owned and operated by the Bass Lake Reservoir Company.

The 250-foot-long, 27-foot-wide uncontrolled, unlined spillway chute is located in the left abutment of the dam, as shown on the site plan (Plate 2).

The low-level outlet is located near the center of the dam. The outlet conduit is a 30-inch-diameter corrugated metal pipe (CMP). The upstream intake consists of two, 24-inch-diameter CMPs that connect to single, 30-inch-diameter pipe with a "Y" shaped connection.

1.2.2 Regional Geology and Seismicity

The geology and seismicity of Bass Lake Dam was addressed in a memorandum by R. D. Eckerlin (Ref. 2). The following information is taken from the memorandum:

> "Bass Lake Dam is located in the headwaters of Bass Creek on the eastern flank of the Bitterroot Range within the Northern Rocky Mountains physiographic province. The Bitterroot Range is composed mostly of late Cretaceous granite and granodiorite of the Idaho Batholith.
>
> A zone of major left lateral translation known as the Lewis and Clark Line, a part of the Montana Lineament, tectonically divides the Northern Rocky Mountains into a Northern and a Southern Province. The Southern Province is broken into several discrete elements, including the Idaho Batholith and Sapphire Detachment Blocks, which are separated by the north-south trending, structurally controlled, Bitterroot Valley. The Lewis and Clark Line has acted as a fundamental tectonic dividing line since the Precambrian. Bass Lake Dam lies about 25 miles south of the Lewis and Clark Line in a region of extremely varied and complex geology. Structural features in the region are a series of nearly parallel thrust faults which trend in an east-southeast direction and which cut across older structures of the Laramide deformation having a north-south trend. Thrust faulting is the dominant type of rock failure in the region and is assumed to have been caused by north-northeastward directed forces.
>
> Evidence of Pleistocene alpine glaciation can be seen in the Bitterroot Range in the form of cirques, moraines, and glacial debris extending down the valleys. Bass Lake is situated within a glacial cirque perched on the northeastern slope of Bass Peak."

The dam lies in Zone 2 of the Seismic Zonation Map of Contiguous States (TM5-809), shown in the Recommended Guidelines (Ref. 1). Bass Lake Dam lies within a zone in which moderate damage can be expected from earthquakes. The dam is adjacent to the seismically quiet Bitterroot Valley. Based on historic seismicity, little risk is expected. Algermissen (Ref. 3) estimates a 90 percent chance of 0.04g acceleration at this dam in a 50-year period.

1.2.3 Site Geology

The following discussion of site geology is taken from an Owen Billingsley (U.S. Forest Service Geologist) memorandum (Ref. 4).

> "Surficial Deposits
>
> Glacial till: Glacial deposits, inferred to be of unstratified clay-to-boulder-sized particles, are expected mostly downstream from the Bass Lake. They usually have high water content and low permeability and are susceptible to mass failure.
>
> Alluvium: Small amounts of well-sorted sand and gravel are probably locally present in the stream bottoms.
>
> Debris fans: Steep, small coalescing fans are seen north of the east end of Bass Lake, near the present dam. These fans probably are formed by debris flows, avalanches, and seasonal runoff, and consist of permeable sand-to-boulder-sized material. If this origin is correct, further such activity probably does not constitute a significant hazard to dam repair or reconstruction.
>
> Avalanche debris: Two small avalanche paths south of Bass Lake are shown on the geologic map (Plates 3 and 4). Lack of large trees indicates periodic avalanche activity, which probably occurs mostly during periods of heavy snowfall when Bass Lake is frozen, and poses no flood danger. During spring melt, though, mixtures of snow and rock could cause waves in the lake with a possibility of overtopping the dam. No direct damage to the structure itself would be expected.
>
> Geologic Structure
>
> No information is available about geologic structures in the Bass Lake basin. Photo lineaments are caused by rock decomposition, soil formation, and forest growth along weak zones in the metamorphic and granitic rock, which probably are the sites of faults and/or major joints. Several lineaments are shown on the map (Plates 3 and 4), none of which cross the present damsite.

> ### Foundation Suitability
>
> Because no field investigation was made, comments as to the foundation at the Bass Creek damsite are limited. A dam has existed at the site for many years, which indicates that with respect to subsidence or failure due to loading or saturation, the foundation materials are stable. The bedrock is fresh, due to extensive glacial scouring, and is not liable to fail along planes of weakness.
>
> ### Landslide or Avalanche Hazard
>
> The chance of structural damage or dam overtopping by mass movement is low. Periodic movements of surficial earth materials are present, as evidenced by avalanche paths and debris fans (Plate 1), but the amount of material in motion during any one episode is probably small.
>
> No known landslides are present; because of thin soil, steep slopes, and continual frost-wedging and rockfall, unstable material apparently has no opportunity to accumulate and fail suddenly."

Onsite inspection of Bass Lake Dam revealed that the right and left abutments consist of glacial deposits with the left abutment covered by rock talus. No information exists describing the foundation materials or the as-built embankment foundation preparation; information in Ref. 4 indicated that approximately the right one-half of the embankment may be founded on bedrock. Borrow areas appear in the glacial sediments at the abutments. The spillway, on the left abutment, is founded in the glacial deposits and is lined with large talus material. The low-level outlet located on the right side of the embankment is not concrete encased and probably does not rest on bedrock throughout its length.

The reservoir shoreline shows signs that past slope movement has occurred. A near vertical fault can be observed crossing the valley in the rock several hundred feet upstream.

1.2.4 Design and Construction History

The Bass Lake Dam Company was organized in 1898 and a log crib dam, filled with rock and dirt, was built in 1902. This dam was enlarged in 1911-1914. The U.S. Forest Service condemned the dam in 1948, and the center section was removed by blasting. In 1951 the group reorganized as the Bass Lake Reservoir Company. The existing Bass Lake Dam was designed by the Farmers Home Administration and was reconstructed in 1952-1953. A U.S. Forest Service report (Ref. 4), providing background information on Bass Lake Dam, indicates that the log cribbing from the original dam was not entirely removed

and that much of this dam was left within the upstream embankment of the new dam. Attached to the owner's letter, in the Appendix, H. L. Morgenstern, engineer in charge of the dam construction, states that the area beneath the present dam was clean to suitable material.

The Forest Service report also indicates there was inadequate clearing and disposal of debris before flooding the reservoir. A berm about 30 feet wide and 20 feet high is located at the downstream toe of the dam and is a departure from the construction plans that show a 1 V on 2 H downstream slope. George Raffatto, of the Bass Lake Reservoir Company, stated that the berm is the result of a survey error that incorrectly located the downstream toe.

There is little information on design or construction, except for four sheets of construction plans copies by the Forest Service from damaged prints of the USDA Farmers Home Administration. A detailed set of construction as-built drawings or information on construction control testing are not available. Plates 2, 3, 4, 7, 8 and 9 were developed from available construction plans.

Chapter 2
INSPECTION AND RECORDS EVALUATION

2.1 HYDRAULICS AND STRUCTURES

2.1.1 Spillway

The spillway for Bass Lake Dam is located in bedrock of the left abutment (Photo 1). The spillway consists of an unlined earth and rock chute approximately 250 feet in length. The crest section of the spillway has a bottom width of 27 feet, a vertical sidewall of stacked rock along the dam embankment, and a side slope of approximately 1 V on 2 H on the left, looking downstream (Plate 5). The crest is 3.1 feet below the low point on the dam crest. The floor of the crest is lined with large rock up to 6 feet in diameter (Photo 2).

The approach channel is composed of earth and small rock up to 1 foot in diameter, and it is unobstructed except for the log boom. The log boom extends into the approach channel. This position could create considerable headloss through the spillway, which would reduce maximum discharges; high velocity flow associated with high discharges may prevent efficient trapment of debris. The spillway discharge channel runs down the abutment contact of the dam and high flows will erode and fail the embankment. The channel has been riprapped with rock 1 to 3 feet, or more, in diameter. The spillway discharges return to the stream channel just downstream of the dam.

The spillway discharge rating was developed by assuming that critical depth occurs at the 27-foot-wide crest section near the dam axis. Headlosses caused by the current location of the log boom were not considered because positioning can be easily changed. Backwater computations were made in the approach channel with a Manning's "n" of 0.04. The maximum discharge capacity of the spillway, with the reservoir at assumed top of dam, elevation 6773.1 feet NGVD, was estimated to be 400 c.f.s. The discharge rating curve is presented on Plate 6.

2.1.2 Outlet

The outlet works for Bass Lake Dam is located through the embankment near the center of the dam. The intake structure could not be inspected during the site visit because of the high reservoir level, but the construction drawings show it as a 5.5-foot by 10-foot concrete structure fitted with a trashrack.

Two 24-inch CMP conduits, each fitted with a 24-inch-diameter sluice gate, extend from the intake structure to a point 13

feet downstream where the 24-inch-diameter conduits are combined into a single 30-inch-diameter CMP conduit. The gate controls are located on the crest of the dam and the gate stem housings follow the upstream face of the embankment to the intake structure (Plate 7). The controls are hand-operated, and two hand cranks are hidden at the site. The controls are exposed to the weather but are in good condition. The 30-inch-diameter conduit extends approximately 200 feet, on an unknown slope, to the outlet structure.

The outlet structure consists of a pair of diverging walls. The end of the floor slab contains a 4-inch-high end sill; the left (looking downstream) portion of the sill is missing, and some rebar is showing (Photo 3). Approximately 2 feet upstream from the sill, there is a 4-inch by 4-inch by 4-inch-high concrete baffle. The downstream channel is well riprapped and is not eroding or backcutting.

The two 24-inch-diameter gates were closed during the site visit and when the 30-inch-diameter conduit was entered for inspection. The conduit is heavily rusted and should be replaced or fitted with a liner in the next few years. Other than rusting, the conduit appeared to be in good condition. A slight deepening of water was noted about midway of the conduit length, indicating some settlement. There was a small amount of water leaking at the left (looking downstream) gate.

The discharge rating for the outlet works was developed with both valves assumed to be fully open. A Manning's "n" of 0.024 was used to estimate friction losses with the conduit flowing full. The maximum discharge capacity of the outlet works with the reservoir at top of dam, assumed elevation 6773.1 feet NGVD, was estimated to be 80 c.f.s.

2.1.3 Freeboard

Because the dam overtops during the probable maximum flood (PMF; see paragraph 2.2.4), there is no freeboard. The vertical distance between the low point on the dam and the reservoir level at the time of the inspection was 6.6 feet. The spillway crest is 3.1 feet below the low point on the dam crest. The crest of the dam varies 0.9 feet over its 300-foot length. The effective fetch for wind-generated waves is about 0.25 mile, and wave runup on the embankment is estimated to be less than 2 feet.

A 2-foot wave runup, combined with a reservoir level slightly above spillway crest, could cause overtopping of the embankment. A high water mark observed during the site visit was 2.3 feet below the low point on the dam crest.

2.2 HYDROLOGY, CLIMATOLOGY, AND PHYSIOGRAPHY

2.2.1 General

The climate of the area is modified continental in nature characterized by warm summers, cold winters, and a semiarid precipitation regime. The nearest climatological station (elevation 3375 NGVD) is at Stevensville, about 11 miles southeast of Bass Lake Dam. Mean annual precipitation at the station is 13.3 inches, 32 percent falling in April through June. Mean February precipitation is 0.90 inches, and mean June precipitation is 1.96 inches. Mean annual precipitation on the Bass Lake Dam drainage basin is probably near 90 inches. Mean annual temperature at Stevensville is 44.3 degrees Fahrenheit (F). Mean January temperature at Stevensville is 22.8 degrees F, and mean July temperature is 69.5 degrees F. Temperatures on the Bass Lake Dam drainage basin may average about 15 degrees cooler than Stevensville. Occasionally, summer temperatures exceed 100 degrees F and winter temperatures dip well below -40 degrees F.

The drainage basin area for Bass Lake Dam is 1.53 square miles, is very irregular in shape, and is on the west side of the Continental Divide. Basin elevations range from 6700 feet at the dam to 9003 on the northern boundary.

Most of the annual precipitation occurs as snow with melt beginning in late April or early May. The basin is very steep, rocky, and about 30 percent forested. An unpublished U.S. Forest Service report (Ref. 4), which provides background information for Bass Lake Dam, states that the estimated average annual runoff is 3,600 acre-feet and that the estimated average annual peak inflow to the lake is about 50 c.f.s. There are no USGS stream gaging stations in the basin or in neighboring basins. A Parshall flume, with a 3-foot-wide throat, is located downstream of the dam.

2.2.2 Reservoir Storage and Spillway Discharge

The reservoir has a surface area of 96 acres and a storage of 3,600 acre-feet at assumed spillway crest, elevation 6700 feet NGVD. Approximately 300 acre-feet of surcharge storage is available in the reservoir between the spillway crest and the dam crest. The spillway discharge with the reservoir at the dam crest is 400 c.f.s.; about 33 acre-feet per hour.

2.2.3 Estimated Probable Maximum Flood

The probable maximum flood (PMF) is the flood expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. An estimate of the PMF was made during the dam safety analysis and was routed through the reservoir.

Procedures available for the area west of the Continental Divide allow for development of a PMP from a thunderstorm or general storm. Because of the size of the Bass Lake Dam drainage basin, a thunderstorm was believed to cause the most critical flood. The procedures contained in Hydrometeorological Report No. 43 (Ref. 5) and the Weather Bureau's 1967 memo (Ref. 6) were used to compute the thunderstorm PMP. The memo allows for some reduction of the PMP that was not originally contained in Report No. 43.

The July or August thunderstorm PMP produces 7.7 inches in 1 hour and 9.4 inches in 6 hours. Because of the high intensity rainfall and the possibility of near saturated soil conditions from thunderstorms on preceding days, a constant 0.15-inch-per-hour loss was assumed during the thunderstorm PMP. A base flow of 15 c.f.s. was used for the entire flood.

The PMF was calculated in two parts for the Bass Lake Dam drainage basin. One hydrograph was obtained from direct precipitation on the lake (with no infiltration), and a second hydrograph was obtained for the remainder of the basin. A triangular unit hydrograph for a 4-minute rainfall duration was developed for the 1.38-square-mile nonlake portion of the drainage basin by procedures outlined in Design of Small Dams (Ref. 7). A curvilinear fit of the triangular unit hydrograph was used. The PMP was applied to the unit hydrograph by means of the computer program, HEC-1, (Ref. 8). This estimate of the PMP produced a flood with a peak flow of 14,600 c.f.s. and a volume of 720 acre-feet.

2.2.4 Flood Routing

The PMF was routed through the reservoir by using the computer program HEC-1 (Ref. 8). The reservoir level was assumed to be at the spillway crest at the beginning of the PMF. The outlet works was assumed to be fully open during the entire flood. Routing studies indicate that:

- During the full PMF, the dam would be overtopped when approximately 45 percent of the flood volume had entered the reservoir.

- Routings were made of lesser hypothetical floods than the PMF to determine the magnitude of floods the dam can contain. The hypothetical hydrographs are obtained by applying percentages to the PMF ordinates. A flood with a hydrograph having ordinates corresponding to one-half the PMF ordinates is just controlled by the project. Larger floods would overtop the dam.

2.3 GEOTECHNICAL EVALUATION

2.3.1 Dam

The 43-foot-high, earth and rockfill embankment is 300 feet long and has a crest width of 33 feet. The upstream slope is 1 V on 3 H, and the typical downstream slope is 1 V on 1.5 H for the upper portion (to elevation 6753 feet NGVD) and 1 V on 2 H on the lower portion, below the bench. Construction drawings show the dam as a zoned embankment, with a downstream zone rockfill. Seepage at the toe and on the downstream slope, estimated at 500 gpm, suggests that the rockfill zone was not constructed. It is likely that the dam was constructed as a homogeneous section of gravelly silt, as shown on Plate 8.

There is no information on procedures used to prepare the foundation surface and to construct the embankment, and no as-built drawing or construction data except that included in the letters bound in the Appendix from George Raffatto, secretary, Bass Lake Reservoir Company, and H. L. Morganstern, Professional Engineer. The existing embankment fill appears to be a gravelly sandy silt. Embankment materials probably were borrowed from glacial sediments at the spillway approach and along the shorelines upstream from the dam.

The brief visual inspection showed that the upstream slope was covered with 18-inch-minus riprap and debris (Photo 5). The riprap layer was placed directly on the embankment fill without a gravel bedding. Some relatively minor wave erosion has occurred along the upstream face.

Material on the downstream slope is a gravelly sandy silt with some rock at the upper slope. The 30-foot-wide bench and the lower slope were covered by logs and partially covered with rock, mainly on the left side of the embankment (Photo 6). The downstream slope, within 80 feet of the right abutment, differed from the typical section and was a uniform slope of 1 V on 1 H. No significant slope erosion, irregularities, slumps, or cracks were present on the dam crest or slopes.

The original plans show the outlet works conduit founded directly on solid rock. However, solid rock was not visible at the outlet works discharge or along the downstream toe. It is possible that the outlet conduit is founded partially on rock some distance upstream. Two cutoff collars are shown in the plans at quarter-points under the upstream portion of the dam.

The left abutment talus slope is downstream of the spillway crest, and dislodged rock should not block the spillway. However, rock movement could direct spillway discharge flow on the downstream slope of the embankment, causing under-

mining of the toe. The location of the talus slope should be inspected periodically to monitor this potentially harmful condition.

2.3.2 Foundation Conditions, Seepage, and Drainage

Both abutments are a glacial moraine. Slightly downstream of the left abutment, a talus slope intersects the spillway slope and embankment toe. Detailed information describing actual embankment foundation materials or preparation was not available. An inspection report by a Forest Service engineer, dated August 26, 1952 (Ref. 4), during construction, stated:

> "Old cribbing left within new dam embankment. Crib logs badly deteriorated. Cutoff trench on south half of dam blasted from solid rock, with sheet piling installed in concrete-filled trench. Cutoff trench on north half of dam in a "hardpan sedimentary formation." Wright was told that the "Water Conservation Board Engineer had o.k.'d this as a base for the piling."

This reference on the actual foundation preparation and construction suggests that even though a portion of the cutoff is not to rock, sheet piling was continued throughout the entire length of the dam. Also, a portion of the original crib dam, described in paragraph 1.2.4, may have remained in the constructed embankment.

During the inspection, with the reservoir level 6 feet below top of dam, seepage was observed at many locations on the downstream slope, primarily on the slope below the bench (lower slope).

When the outlet works gates were closed to inspect the pipe, the remaining flow downstream was reservoir seepage and was estimated to be 500 gpm. Most of the seepage was observed at the left side of the dam (Photo 9) in the areas shown on Plate 9. Much of the seepage was measured at the same elevation, and it is possible that a layer of embankment material more pervious than the majority of the fill is transmitting most of the seepage.

No erosion or evidence of embankment or foundation fines movement associated with seepage were observed. Seepage was observed during the first detailed inspection, July 14, 1969, several years after the reservoir was filled, as noted in a U.S. Forest Service Report (Ref. 4):

> "Seepage appearing on the downstream face of the north half of the dam was estimated at 20-40 gallons per minute. Also, seepage flow of about 5-10 gallons per minute was found adjacent to the headwall of the outlet."

The apparent 10-fold increase in seepage quantities from 1969 (50 gpm) to 1979 (500 gpm) suggests the large difference may be the result of measuring inaccuracies. In any case, further investigation of seepage is warranted.

2.3.3 Stability

No stability analyses or embankment strength characteristics were available for review. Also, there are no construction quality control records or construction specifications available. Because a portion of the embankment near the right abutment has a downstream slope of 1 V on 1 H, and a high steady state seepage line exists on much of the downstream slope, it is our judgment that embankment stability does not conform to the guidelines; however, sufficient information is not currently available for complete evaluation.

2.4 PROJECT OPERATION AND MAINTENANCE

The facility is owned and operated by the Bass Lake Reservoir Company. Information on operation and maintenance was obtained from the U.S. Forest Service background report on Bass Lake (Ref. 4) and from discussions with Mr. George Raffatto, secretary of the Bass Lake Reservoir Company. The outlet works is operated to minimize discharges through the spillway.

2.4.1 Dam

Dams in wilderness areas, such as Bass Lake Dam, require special considerations for maintenance, repair, and reconstruction. Basically, the Wilderness Act states that protection of the wilderness resource must be a prime consideration when making plans to maintain a wilderness dam. The law prohibits the use of motorized equipment except when prior approval is given by the land managing agency. Approval for the use of motorized equipment for the inspection or maintenance of dams within wilderness areas is required from the Regional Forester.

The dam is visited on horseback as soon as allowed by spring snowmelt. Additional visits are made approximately every 10 days during the irrigation season when releases are being made from the reservoir. The U.S. Forest Service conducts inspections of the facility at 2-year intervals and makes recommendations for maintenance and repairs at that time. The Bass Lake Reservoir Company performs maintenance annually regardless of whether the Forest Service inspectors are scheduled. The Special Use Permit calls for maintenance of a spillway log boom and removal of driftwood and debris in front of the log boom and dam. Debris continues to be a problem because reservoir clearing was not completed prior

to filling the reservoir. The reservoir company is continuing debris cleanup operations. This maintenance problem is compounded because the reservoir is located within a wilderness area (remote motorized equipment). The reservoir company has applied for and received permission to use chainsaws several times in the past. Another debris removal problem is the lack of area to store the material for drying and burning; the downstream face of the dam is littered with logs that have been removed from the reservoir.

2.4.2 Reservoir

Water from Bass Lake Dam is used for irrigation and Mr. Ruffatto serves as the gate operator. The reservoir is usually filled by spring snowmelt, and maximum storage is normally reached by mid-June. Irrigation releases usually begin by mid-July and are ended by early to mid-September. The reservoir is normally drawn completely down by the end of the irrigation season.

The dam is visited approximately every 10 days during the irrigation season, depending on water needs. Both outlet gates are opened approximately the same amount to obtain the desired discharge. A Parshall flume downstream of the dam is used to determine the appropriate gate settings.

2.4.3 Warning System

There is no formal warning plan for use in the event of impending dam failure.

Chapter 3
FINDINGS AND RECOMMENDATIONS

3.1 FINDINGS

Visual inspection of the dam, supplemented by analysis of the project in terms of the recommended guidelines' performance standards, resulted in the following findings.

3.1.1 Size, Hazard Classification, and Safety Evaluation

In accordance with inspection guidelines, Bass Lake Dam is intermediate in size with a high downstream hazard potential rating. The recommended spillway design flood (SDF) for this project is the full PMF. The project can safely control approximately 50 percent of the PMF ordinate without overtopping and causing the dam to fail. Because the project is not capable of controlling the full PMF without overtopping and causing the dam to fail, Bass Lake Dam does not meet inspection guidelines (Ref. 1).

3.1.2 Embankment Dam

A brief visual inspection of the dam embankment revealed no serious cracks, irregularities, or slumps. Minor erosion had taken place on the upstream face and along the right abutment contact. Seepage, estimated at 500 gpm for the entire embankment, was flowing primarily from the left, downstream side of the embankment, to the downstream bench and the downstream toe. The seepage is clear; however, estimated seepage at the time of our inspection was approximately ten times that previously reported in 1969. There is no information on how the embankment was actually constructed, or strength characteristics of embankment materials; therefore, stability cannot be evaluated.

3.1.3 Spillway and Reservoir Capacity

The reservoir has a surface area of approximately 96 acres and a storage of 3,600 acre-feet at assumed spillway crest, elevation 6770 feet NGVD. Approximately 300 acre-feet of surcharge storage is available in the reservoir between the spillway crest and the dam crest. The discharge capacity of the spillway, with the reservoir at the dam crest, is 400 c.f.s. The present log boom would reduce this maximum discharge. The spillway discharge channel runs down the abutment contact of the dam, and high flows could erode the embankment.

3.1.4 Outlet Works

The gates were closed and the conduit was entered during the site visit. The CMP conduit is heavily rusted and should be

replaced or fitted with a liner in the next few years. A slight deepening of water was noted about midway of the conduit length, indicating some settling. There was a small amount of water leaking at the left (looking downstream) gate.

3.1.5 Operation and Maintenance

The U.S. Forest Service conducts annual inspections of the facility and makes appropriate recommendations for maintenance and repairs at 2-year intervals. The dam is located in a wilderness area and approval for the use for motorized equipment for inspection or maintenance must come from the Regional Forester. The reservoir company has applied for and received permission to use chainsaws several times in the past to remove reservoir debris. Because reservoir clearing was not completed prior to filling the reservoir, debris continues to be a problem. The reservoir company performs maintenance as needed, and usually as a result of the Forest Service inspection.

The reservoir is usually filled by spring snowmelt and maximum storage is usually reached by mid-June. Irrigation releases usually begin in mid-July and are ended by late August or early September. The reservoir is normally drawn completely down by the end of the irrigation season. Mr. Ruffatto visits the dam about every 10 days by horseback during the irrigation season. There is no formal warning plan for use in the event of impending dam failure.

3.2 RECOMMENDATIONS

Because of storage between normal pool and dam crest, the present project provides a degree of flood protection to the downstream area. The intent of report recommendations is to maintain or improve project safety without decreasing this flood protection. The findings suggest that high priority be given the following recommendations:

1. Immediately develop, implement, and periodically test an emergency warning plan for use in the event of impending dam overtopping or structural failure.

2. Make plans for replacement of the outlet conduit or fit it with a liner within the next 2 years. Also, modify the intake structure to avoid the flat trashrack over the intake to avoid plugging problems.

3. Reconstruct the log boom so it is not within the spillway approach channel and secure ends so that the boom functions for all reservoir levels.

4. Provide protection to prevent spillway flows from eroding the embankment along the left abutment of the dam.

5. Continue program to clear reservoir debris. Remove the debris from the downstream slope.

6. Conduct more detailed hydrologic and hydraulic routing studies to better determine the downstream hazard and required spillway capacity, and modify the project as studies indicate.

7. Conduct embankment stability analyses and seepage evaluation using data from field investigations and laboratory tests, as appropriate, and using embankment water levels (phreatic surface) determined by installing and monitoring piezometers. Measure seepage by installing and reading weirs. Design and implement dam modifications as necessary to ensure stability. We recommend all studies be performed by qualified engineers.

8. Conduct periodic inspections of Bass Lake Dam at intervals not to exceed 5 years, by engineers experienced in dam design and construction.

REFERENCES

1. U.S. Army Corps of Engineers, Office of the Chief of Engineers Report to the U.S. Congress, National Program of Inspection of Dams, Vol. 1, Appendix D, "Recommended Guidelines for Safety Inspection of Dams," Washington, D.C., Department of the Army, May 1975.

2. Richard D. Eckerlin, U.S. Army Corps of Engineers, Memorandum on Flint Creek (East Fork, Rock Creek) Dam Inspection, August 1979.

3. S. T. Algermissen and D. M. Perkins, "A Probabilistic Estimate of Maximum Accelerations in Rock in the Contiguous United States," Bulletin, U.S. Department of the Interior, Open file report, U.S. Geological Survey, No. 76-416, 1976.

4. U.S. Forest Service, Bitterroot National Forest, "Background Data, Bass Lake Dam," 1977.

5. U.S. Weather Bureau, Hydrometeorological Report No. 43, "Probable Maximum Precipitation, Northwest States," Washington.

6. Hydrometeorological Branch, U.S. Weather Bureau Office of Hydrology, "Memorandum: Probable Maximum Thunderstorm Rain for the Columbia River Basin East of the Cascade Ridge," September 20, 1979.

7. U.S. Bureau of Reclamation, "Design of Small Dams," 2nd Edition, 1974.

8. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-1 Flood Hydrograph Package, Davis, California, January 1973.

APPENDIX

DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION
WATER RESOURCES DIVISION

THOMAS L. JUDGE, GOVERNOR
32 SOUTH EWING
STATE OF MONTANA
(406) 449-2872
HELENA, MONTANA 59601

February 22, 1980

Department of the Army
Seattle District, Corps of Engineers
P.O. Box C-3755
Seattle, Washington 98124

Attn: Ralph Morrison

Re: CH_2M Hill final draft Dam Safety Inspection Report on Bass Lake Dam (MT-1176).

Dear Ralph:

We have reviewed the above referenced final draft report on Bass Lake Dam near Florence, Montana. We concur with the findings and recommendations and find the report satisfies the criteria for the Phase I evaluation. Minor editorial comments have been discussed with your staff, and we understand these will be incorporated in the final report.

Thank you for this opportunity to review and comment on the final draft report for this project.

Sincerely,

Richard L. Bondy

Richard L. Bondy, P.E.
Chief, Engineering Bureau
(406) 449-2864

RLB:AT:mb

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FEDERAL BUILDING MISSOULA, MONTANA 59801

7530

Sidney Knutson, P.E.
Assistant Chief, Engineering Division
Seattle District Corps of Engineers
P. O. Box C-3755
Seattle, Washington 98124

Dear Mr. Knutson:

As requested in your letter of January 28, we have reviewed the draft report on the Phase I inspection of Bass Lake Dam.

We agree with the report recommendations and suggest consideration be given in the recommended hydrologic study that a "dam-break" analysis be included to properly define the hazard the dam presents in storm and non-storm conditions.

Sincerely,

R.W. Larse

R. W. LARSE
Regional Engineer

cc: Bitterroot NF

February 19, 1980

Vernon E. Cook Jr.
Sidney Knutson, P.E.
Asst. Chief, Engineering Division
Departmnet of the Army
Seattle District, Corps of Engineers
Seattle, Washington 98124

Dear Sirs;

Thank you for the opportunity to comment on the final inspection report of Bass Dam. Bass Lake Reservoir Company is interested in maintaining or improving this dam to provide maximum reasonable safety for all concerned, while continuing to supply water for irrigation, recreation, fisheries and aesthetics as well as downstream flood control.

While we agree with many findings of the report we feel there are several areas of concern where further comment or clarification is needed.

Major areas of concern include:

1. Information on foundation materials and dam construction
2. The irrigation use data
3. The calculation of Probable Maximum Flood
4. The placement of the log boom

Other areas needing further investigation include the seepage on the downstream face of the dam and other minor changes that will be noted below.

Information to support these comments is drawn from personal knowledge of the Bass Lake Reservoir Company and statements (enclosed) from Harold Morgenstern, the engineer in charge of construction of the dam,

Dale S. Thacker, currently District Forest Ranger, Stevensville R. D., and Charles H. McDonald, Forest Ranger, Retired, who was District Forest Ranger on the Stevensville District during the years the dam was constructed.

A section by section commentary follows.

Sincerely,
George Ruffatto
GEORGE RUFFATTO
Bass Lake Reservoir Company

BASS LAKE RESERVOIR COMPANY COMMENTARY

1.2.1 page 5 last sentence on page

Refer to Harold Morgenstern letter (attached) concerning construction materials. The dam is reinforced with steele sheeting and concrete.

1.2.1 page 6 3rd paragraph

Refer to Harold Morgenstern letter (attached) concerning the spillway construction. The spillway is blasted out of bedrock as necessary and paved with graded rock.

1.2.4 page 12 8th line

Refer to Harold Morgenstern letter & C.H. McDonald letter (both attached) concerning the fact that all the old dam was removed prior to construction of the new dam.

2.1.1 page 14 1st line

Refer to Harold Morgenstern letter (attached) concerning spillway construction. The spillway is blasted down to bedrock and paved with graded rock.

2.1.1 page 14 12th line

The log boom was positioned, unsuccessfully, twice before the present location was finally selected. The previous boom locations were across the entire reservoir; first 200 yards out, then 50 yards out. Each year the winters accumulation of ice destroyed the boom and it was ineffectual in preventing accumulation of debris on the dam face and in the spillway. The present location protects the spillway from debris accumulation and has never been affected by ice. We would be open to suggestions on how the boom placement could be changed to accomplish its purpose

without danger of being destroyed.

2.1.1 page 15 2nd to last sentence

The Forest Service has been measuring discharges on Bass Creek for the past 3 years. These measurements are a matter of public record. Peak discharges have been measured each year and the maximum recorded discharge is 122.53 CFS on June 8, 1978. The measurement is taken just above Charles Waters Cqmpground in the SW S32 T10 NR 20W. The area drained at this point is over 13 square miles. The drainage area of the dam spillway at the head of Bass Creek is 1.53 square miles (page 18 of inspection report). The point is that spillway capacity is quite large compared to water that could reasonably be expected to pass through it. Also refer to Harold Morgenstern letter (attached) in which he states spillway capacity is 10 times the computed runoff for the watershed above.

2.2.1 page 18 8th line

An apparent typo - June precipitation is mentioned twice with different figures each time.

2.2.3 page 19 last paragraph

The probable maximum flood section proposes a reasonably possible set of meteorlogic and hydrologic conditions which could cause flooding. In our opinion amounts proposed are not only unreasonable but ludicrous. We feel further study on this section is needed.

2.3.1 page 22 8th line

Refer to Harold Morgenstern letter & C.H. McDonald letter (both attached) stating that rock fill zone was constructed.

2.3.2 page 24 2nd paragraph

Refer to our item on paragraph 1.2.4 above. Old dam was completely removed as verified by attached letters (Morgenstern & McDonald).

2.3.2 page 25 3rd paragraph thru end of section

The seepage mentioned in this section needs further investigation. Bass Lake Reservoir Company members and others (statements attached) present when the dam was constructed remember that water from the north side talus slope was seeping in this area. A Forest Service test donein late summer of 1970 shows that seepage may not be a result of reservoir leakage. In this test, dye was placed in the reservoir. The seepage was observed to determine if it would show the same coloration. The results were negative. See attached letter by Ranger Thacker. We will check the apparent 10 fold increase in seepage by observation during regular dam visits this year.

2.4.1 page 27 17th line

Bass Lake Reservoir Company has performed maintenance annually whether Forest Service inspects or not. See Ranger Thacker's letter attached. Debris accumulating on the upstream face of the dam is estimated to be less than 10% of the original amount, and may well be due to minor slides and avalanches occurring each spring rather than lack of reservoir cleaning previously.

2.4.2 page 28

This section needs revision. Several statements are erroneous and others need amplification. We propose a rewritten section as follows:

> Water from Bass Lake Dam is used for irrigation and Mr. Ruffatto serves as the gate operator. The reservoir is usually filled by

spring snowmelt and maximum storage is usually reached by mid-June. Irrigation releases usually begin in mid-July and are ended by early to mid-September. The reservoir is normally drawn completely down by the end of the irrigation season. Water always lasts at least 60 days from opening the gate on a full reservoir and is never depleted before late August. The irrigation water in the reservoir is always used. The dam is visited approximately every 10 days during the irrigation season, depending on water needs. Both outlet gates are opened approximately the same amount to obtain the desired discharge. A Parshall flume downstream of the dam is used to determine when appropriate gate settings are made. The irrigation water is used on approximately 3300 acres for the growing of alfalfa, clover, and grass hay; small grain (wheat, barley, and oats); corn, and improved irrigated pasture. Appriximately 1175 head of cattle are kept in the area served by Bass Lake Dam and Reservoir. The gross economic product is estimated at over $532,000.00. The agricultural operation under the dam and reservoir provide jobs for 14 persons on a yearly basis and 7 to 10 persons on a seasonal basis. Without the storage facilities of Bass Lake Dam and Reservoir, the gross economic product would be curtailed by at least 65%. The personnel employed would also be curtailed by a comparable amount. The actu~~r~~al construction costs of Bass Lake Dam were financed by the Farmers Home Admin. in 1950-1953 and were totally repaid by the Bass Lake Reservoir Company without any Federal or State assistance.

3.1.1 page 30 last sentence

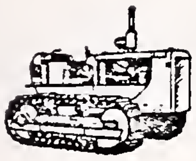
Please clarify guidelines.

3.2 page 33 Recommendation 2

The trash rack as it presently exists has been very satisfactory for the past 27 years. We can see nothing gained by replacement. CMP repair will be accomplished as necessary.

3.2 page 34 Recommendation 3

Refer to our comment on section 2.1.1, page 14.



EAST SHORE ENGINEERING
& CONSTRUCTION
P.O. Box 678
Bigfork, Montana 59911
Phone (406) 837-6125

February 14, 1980

Mr. Joe Canton
Canton Ranch
Stevensville, Montana 59870

Dear Joe:

I received your letter of February 12, 1980, regarding the Army Corps of Engineers questions on the Bass Lake Dam.

I will attempt to answer your questions from the few records I have and memory, however, if more detailed information is needed, it will be necessary to go to the dam site in the spring and gather more information for records lost.

Question 1: Was any of the old Bass Lake Dam site left within the present dam?

The answer is no. In fact, the lake was lowered approximately 15 feet which was the trench site for the outlet tube. The entire area under the present dam was clean down to suitable material which, of course, removed all of the old structure.

Question 2: Is the foundation of the present dam built on bedrock?

After clearing the entire base of the dam we dug a 20 foot core trench across the base to receive the dam core. Thirty foot steel interlocking sheet pilings were driven to refusal in this trench. The sheet piling penetrated approximately 15 feet below the bottom of the core trench and protruded 15 feet into the selected core. It is our assumption that the steel sheets were driven to bedrock because this type of sheet piling normally will penetrate anything except bedrock.

Question 3: Describe nature of the materials used in the construction of the present Bass Lake Dam.

It is our recollection the outlet tube is 24 inch pipe. This could be varified. The guage of the pipe could also be varified. The CMP was galvanized and asphalt treated and since concrete was not available at the site, 4 galvanized, asphalt treated steel collars were used at the correct location within the dam core. These collars

were 3 feet larger than the outside of the tube. An Armco cast iron #101 gate was used for control with the stem supported on the dam face. In constructing the dam proper, the earth fill was spread in 6 inch layers, watered when necessary, and rolled with sheet foot roller. A spring tooth harrow was used to prepare each layer for a bond with the next layer. Selected material was always placed in the dams core and rocks were sorted out and pushed to the face of the dam for rip rap and the larger rocks to the slope on the downstream side. The exact size of this core can be determined if and when the writer has a cross section of the dam proper because the size and location of the selected core would meet the requirements of good engineering practice for earth fill dams. Extreme care was taken to place selected material and compact on each side of the steel sheets, around the outlet tube, and collars. A hole was cut through the steel sheet piling to receive the outlet tube which was caulked and asphalt treated. A spill way was constructed by blasting in solid rock where needed and the remainder of the spill way paved with graded rock. Please be advised that the capacity of the spill way is ten times the computed run off for the water shed above.

Since the Farmers Home Administration had no qualified engineering staff, the writer assumed the responsibility of design, supervision, and construction. Please be advised that the writer is a graduate of Colorado State University in 1938 with a degree of Civil and Irrigation Engineering. At that time Colorado State was the leading school in the construction of earth fill dams. I can assure you the Bass Lake Dam considerably exceeds the cross section dimention requirement for earth fill dams according to good engineering practices. I can also assure you that constant supervision was available at all times to insure proper moisture content and maximum compaction.

Please rest assured that the Corps can find no reason for eliminating this dam and if further information is needed, we will be happy to furnish you with it.

Yours truly,

H. L. Morgenstern

H. L. Morgenstern
Professional Engineer and Land Surveyor
M. S. Lic. No. 358E.S.

HLM/djm

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Stevensville Ranger District
Stevensville MT 59870

REPLY TO: 2720 Special Uses

February 19, 1980

SUBJECT: Bass Creek Reservoir
Corps of Engineer Report

TO: George Ruffato
Stevensville, MT 59870

In response to your request for verification of structural maintenance of the dam, I certify that all required work, including debris removal, boom maintenance, vegetative and animal control have been done on an annual basis.

Our files in Hamilton relate the use of dye by Engineers Ballard and Stensetter in the reservoir to check possible seepage in the dam structure. The report does not indicate that the dye laden water permeated the dam.

Dale S. Thacker
DALE S. THACKER
District Ranger

cc: S.O.

DSThacker:kw

February 19, 1980

TO: Bass Lake Reservoir Co.
% George Ruffatto
Stevensville, Mt.

Dear George;

I was District Forest Ranger on Stevensville Ranger District during the time that Bass Dam was built. I personally visited the dam site many times during the actual construction. I know that Forest Service engineers made sure all remains of the old dam were completely removed before the new one was constructed.

Also, Plate 8, appended to the inspection report notes on the lower diagram that the cutoff probably does not exist. I recall that it was in fact installed as shown on the upper diagram.

I feel that much of the seepage originates on the talus slope north of the dam. This water was present during the construction of the dam, and I believe it may be, at least in part, responsible for the present seepage observed during inspections.

C H McDonald
C.H. MC DONALD
Forest Ranger, Retired

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT. CORPS OF ENGINEERS
P.O. BOX C-3755
SEATTLE. WASHINGTON 98124

NPSEN-FM

28 May 1980

Mr. George Ruffatto
Bass Lake Reservoir Company
Stevensville, Montana 59870

Dear Mr. Ruffatto:

Thank you for your comments and additional information on Bass Lake Dam. Your comments and Mr. Morgenstern's regarding construction procedures will be incorporated into the design and construction history section of the report.

The size of the spillway design flood (SDF) was determined, as outlined by the guidelines, by the dam height, reservoir size and downstream hazard potential of the project. For your project, our guidelines recommend a probable maximum flood (PMF) for the SDF. The guidelines require the project to handle 100 percent of the PMF; our preliminary analysis indicates the project can handle approximately 1/2 the PMF without overtopping and causing the dam to fail, therefore the project does not meet the guidelines. With regard to your question on clarifying the "guidelines," we are referring to the "Recommended Guidelines for the Safety Inspection of Dams," which represent the comprehensive consensus of the engineering community. A copy of the guidelines was previously sent to you.

In regards to the probable maximum flood (PMF) derivation, it was estimated based on accepted procedures and, although floods approaching the PMF may never have been historically experienced in the project area, represents what could happen. It is recognized that refinements in the preliminary PMF could either increase or decrease the final flood estimate; accordingly, we have included a recommendation to conduct more detailed hydrologic and hydraulic routing studies to better determine the downstream hazard and required spillway capacity and modify the project as studies indicate.

Your entire response will be appended to the final Dam Safety Inspection Report.

Sincerely yours,

SIDNEY KNUTSON, P.E.
Asst. Chief, Engineering Division

PHOTO 1

Spillway--Right side looking upstream.

PHOTO 2 Spillway Crest.

PHOTO 3 Low level outlet exit structure.

PHOTO 4 Drainage basin looking upstream from dam.

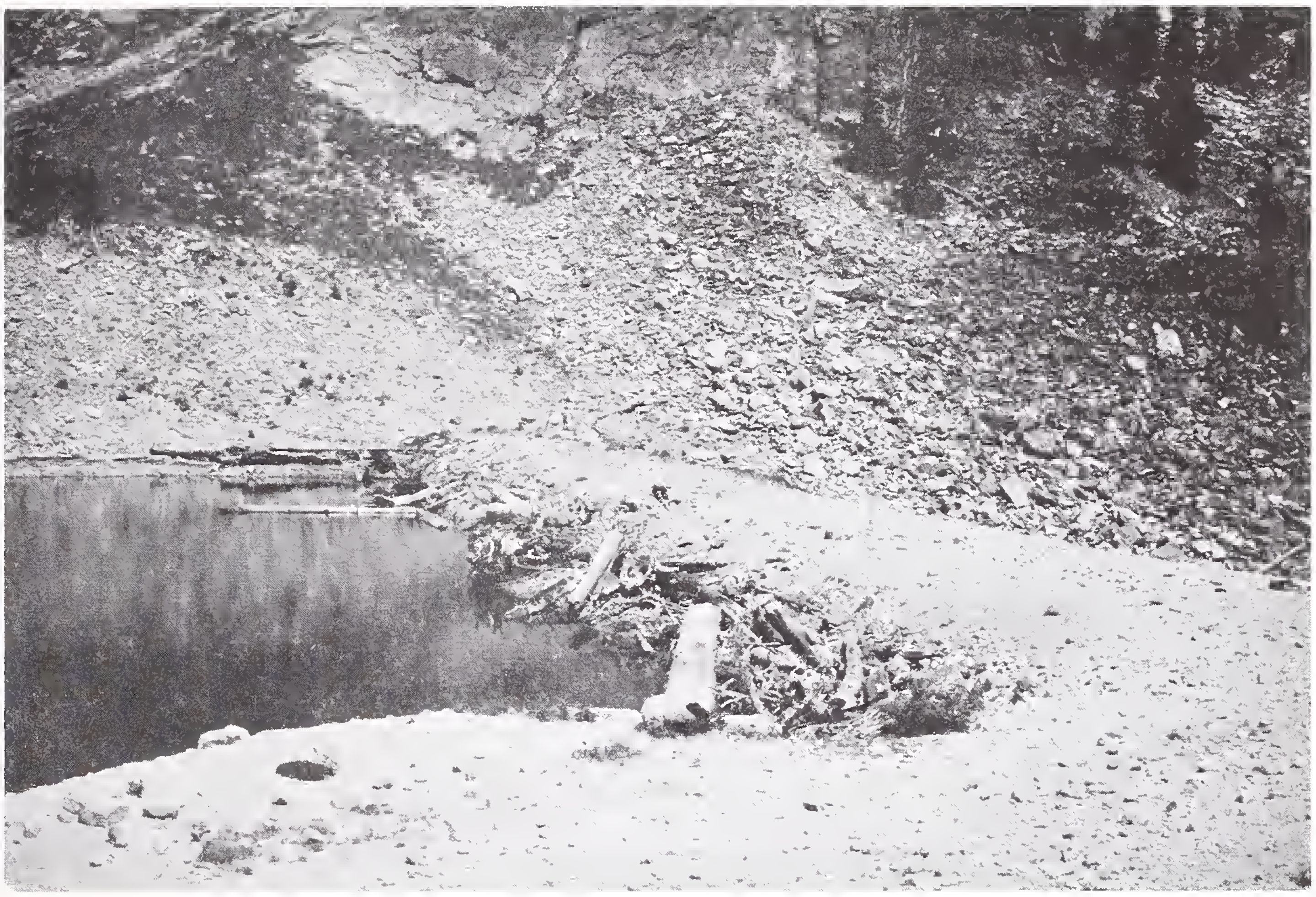


PHOTO 5 Upstream slope.

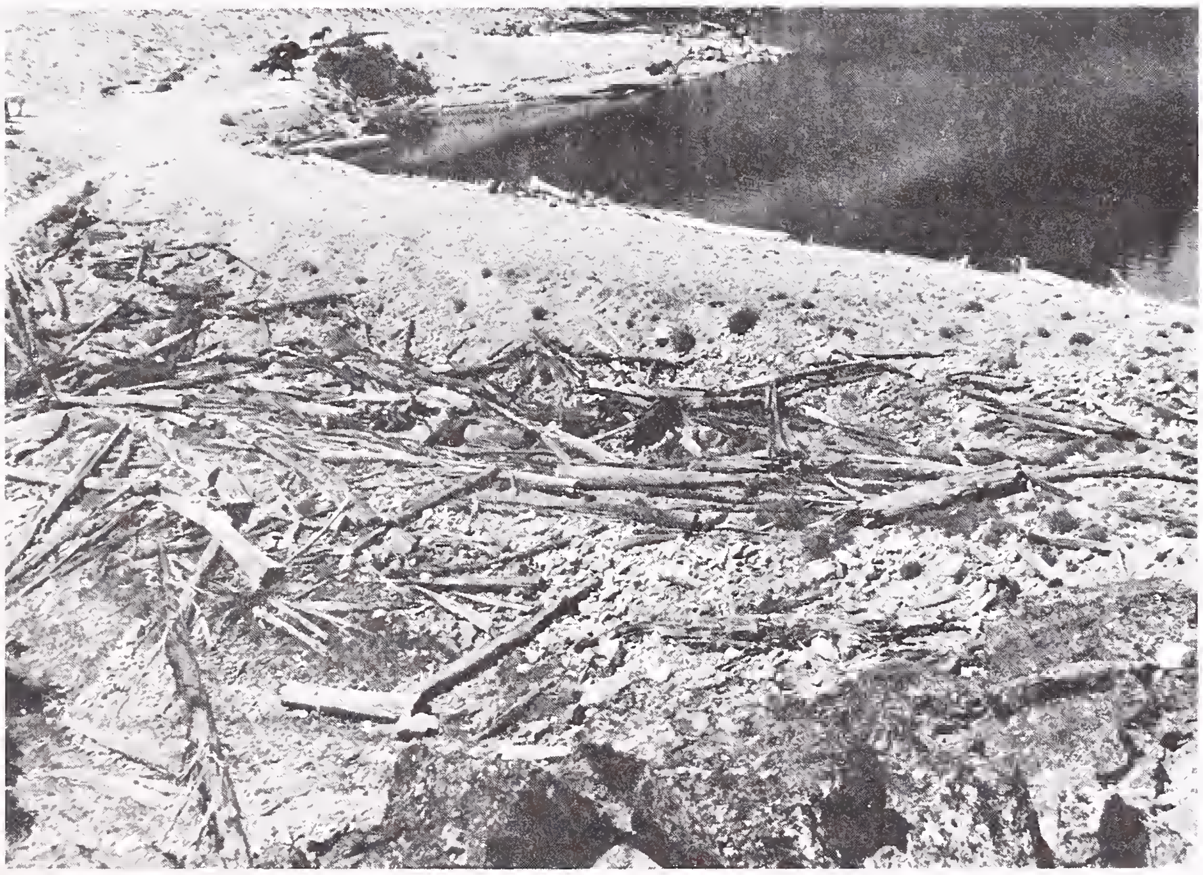


PHOTO 6 Downstream slope.

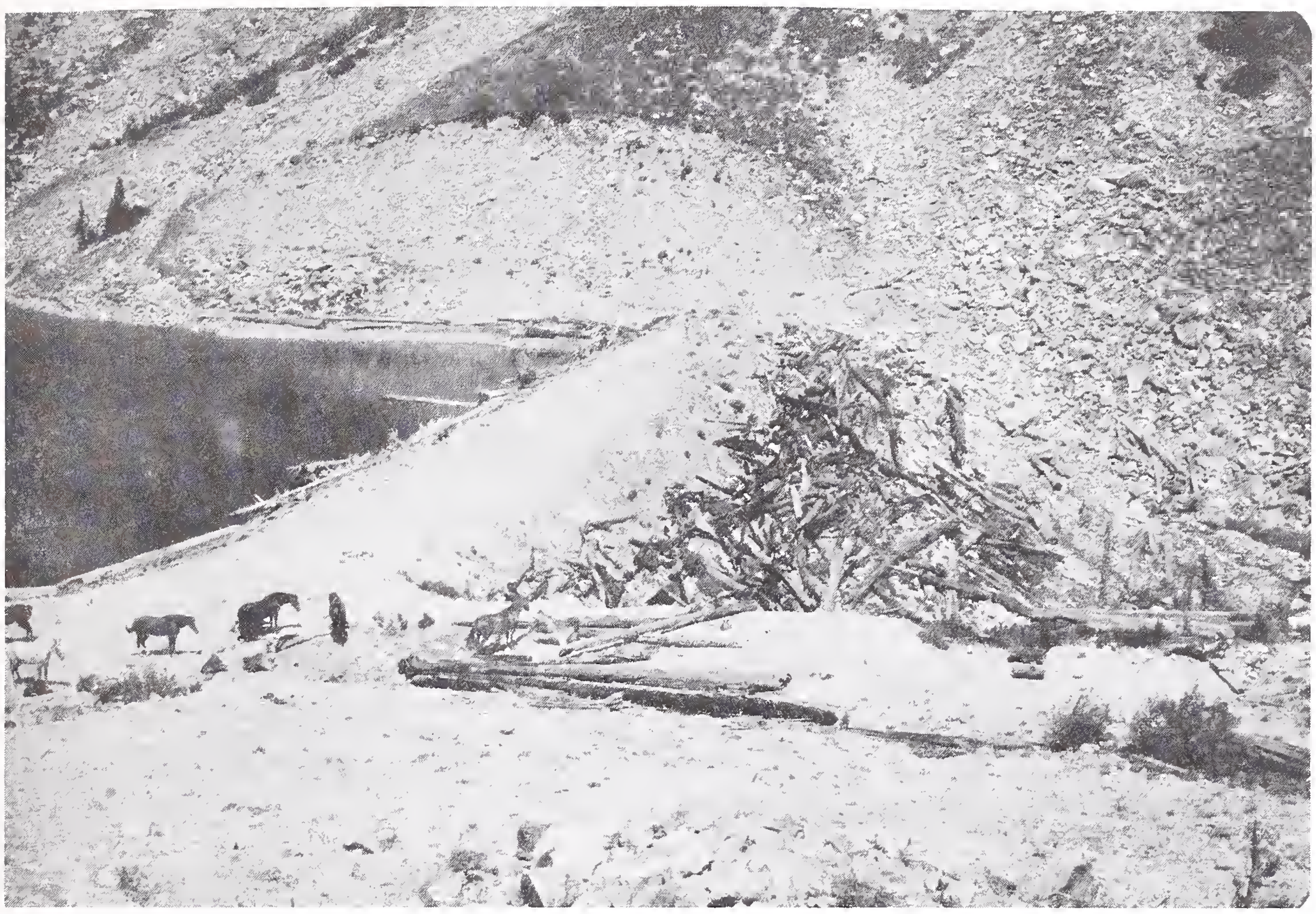


PHOTO 7 Left abutment--talus slope.

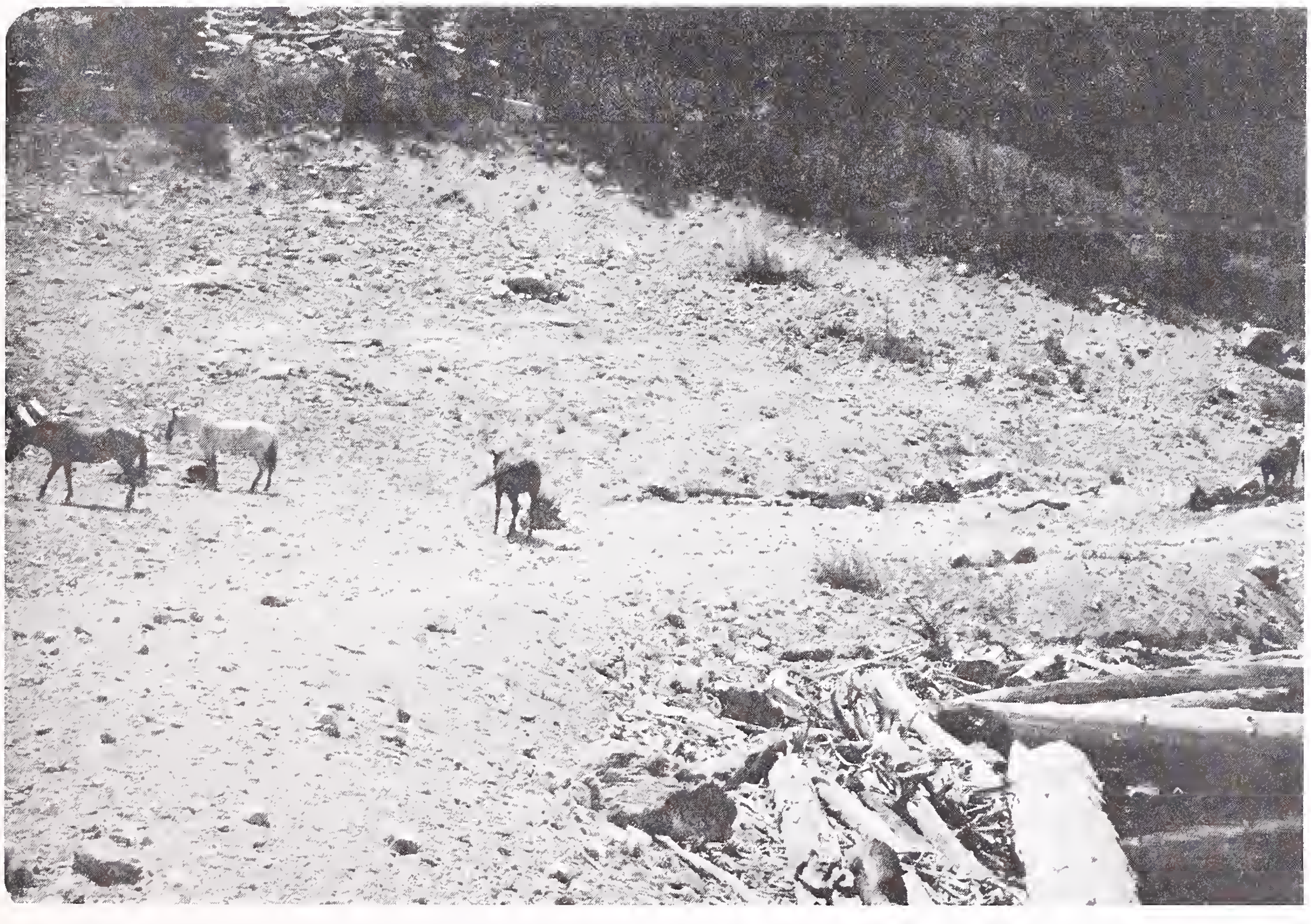
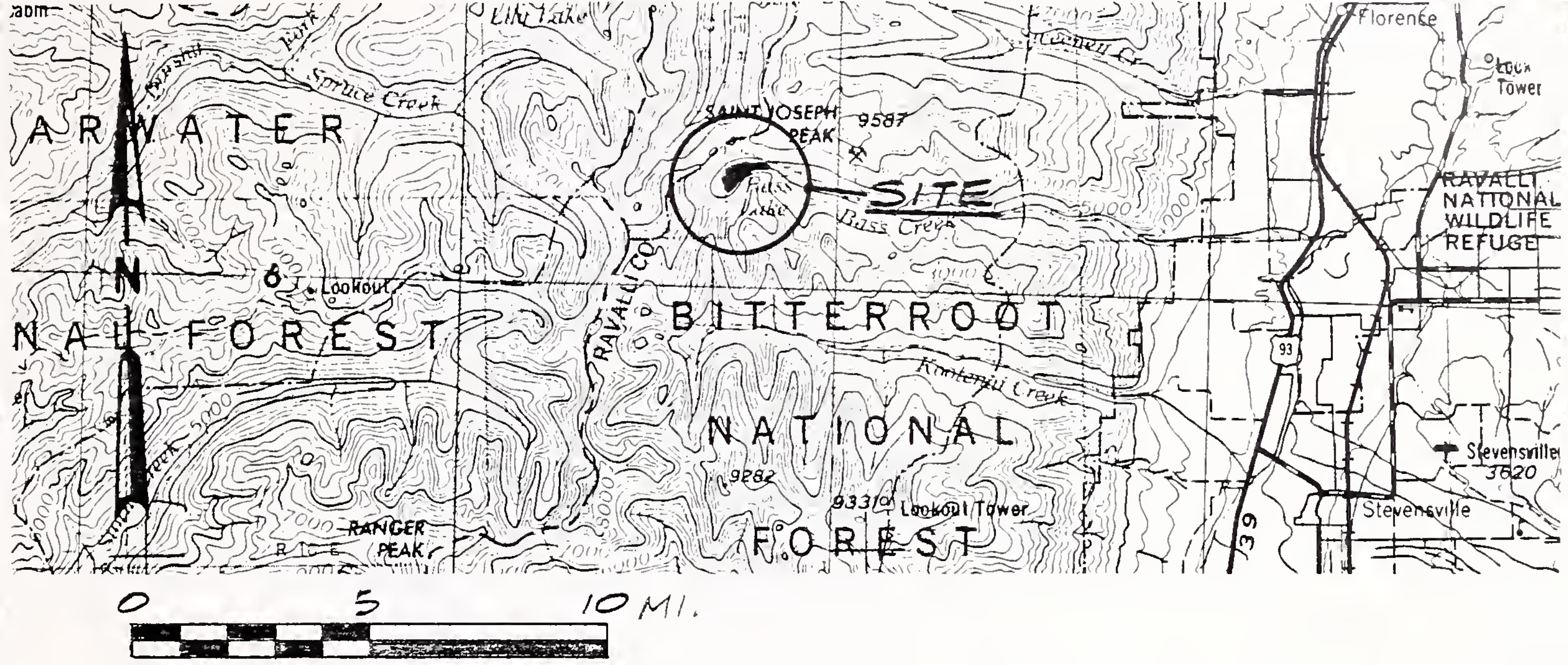
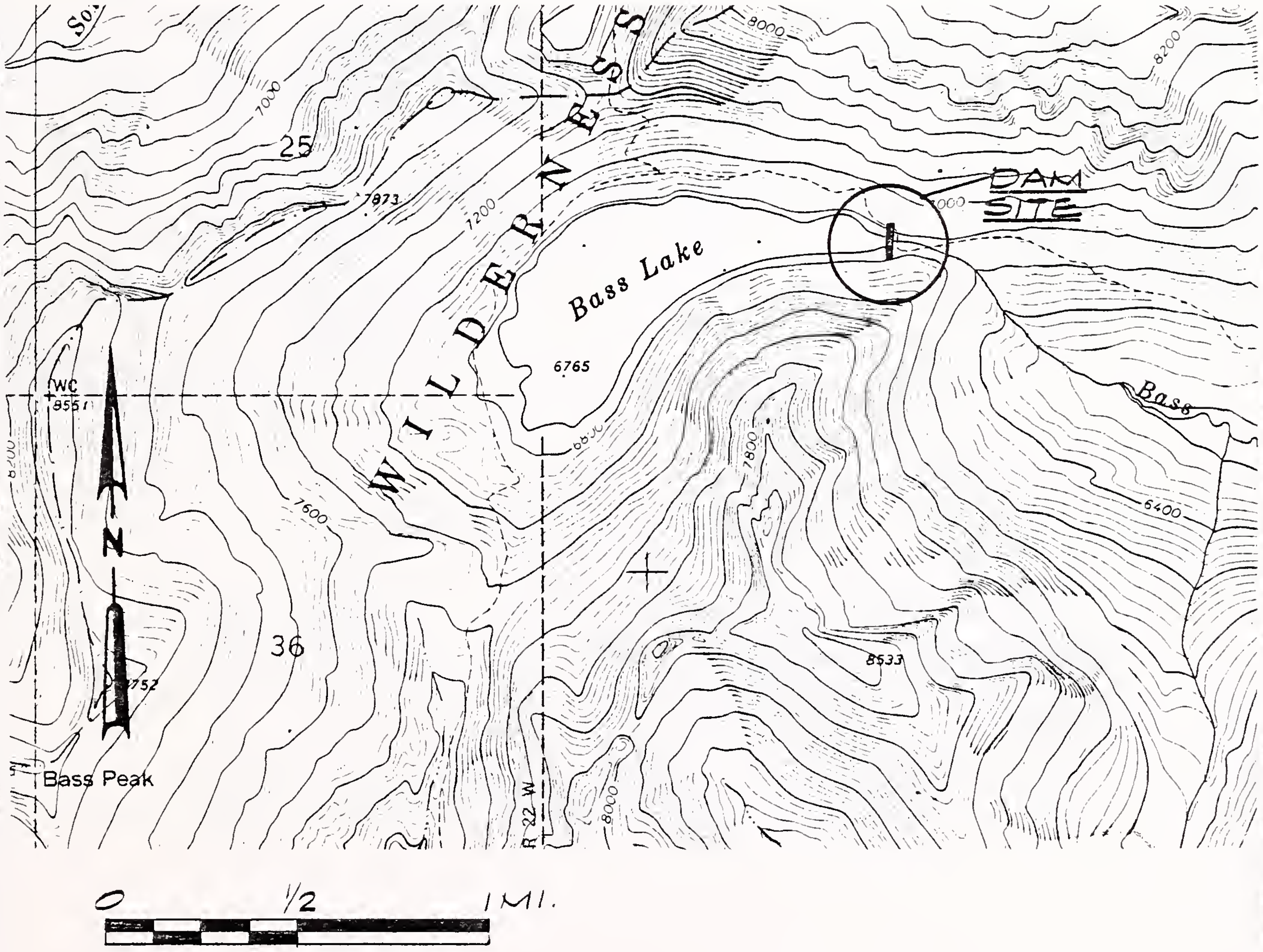


PHOTO 8 Right abutment.

PHOTO 9 Left abutment of spillway showing some of the seepage flowing into the outlet discharge.



SCALE 1:250,000



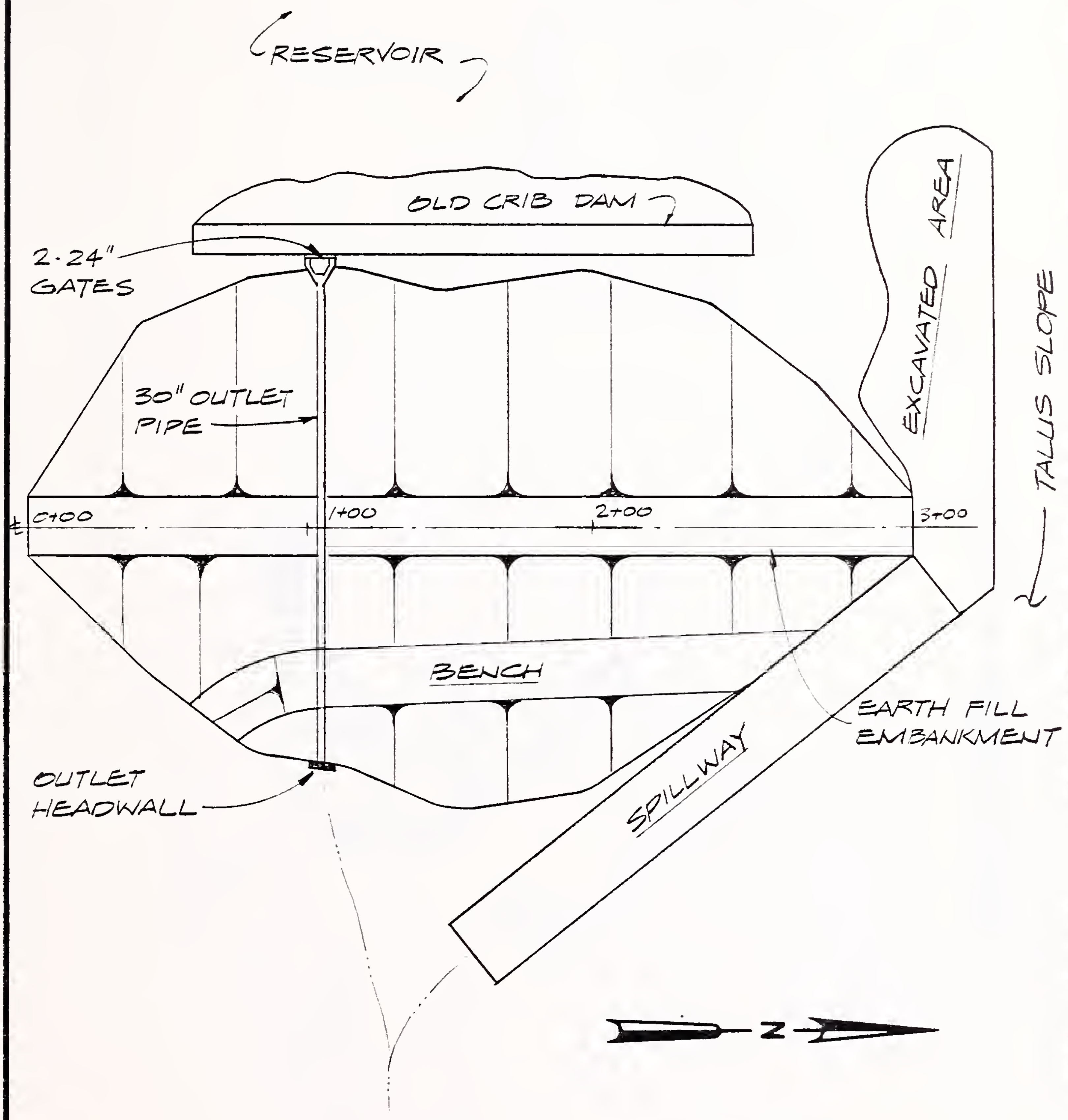
SCALE 1:24,000

PLATE 1

BASS LAKE DAM

VICINITY MAP

CH2M HILL



SITE PLAN
N.T.S.

PLATE 2
BASS LAKE DAM
SITE PLAN

CH2M
HILL

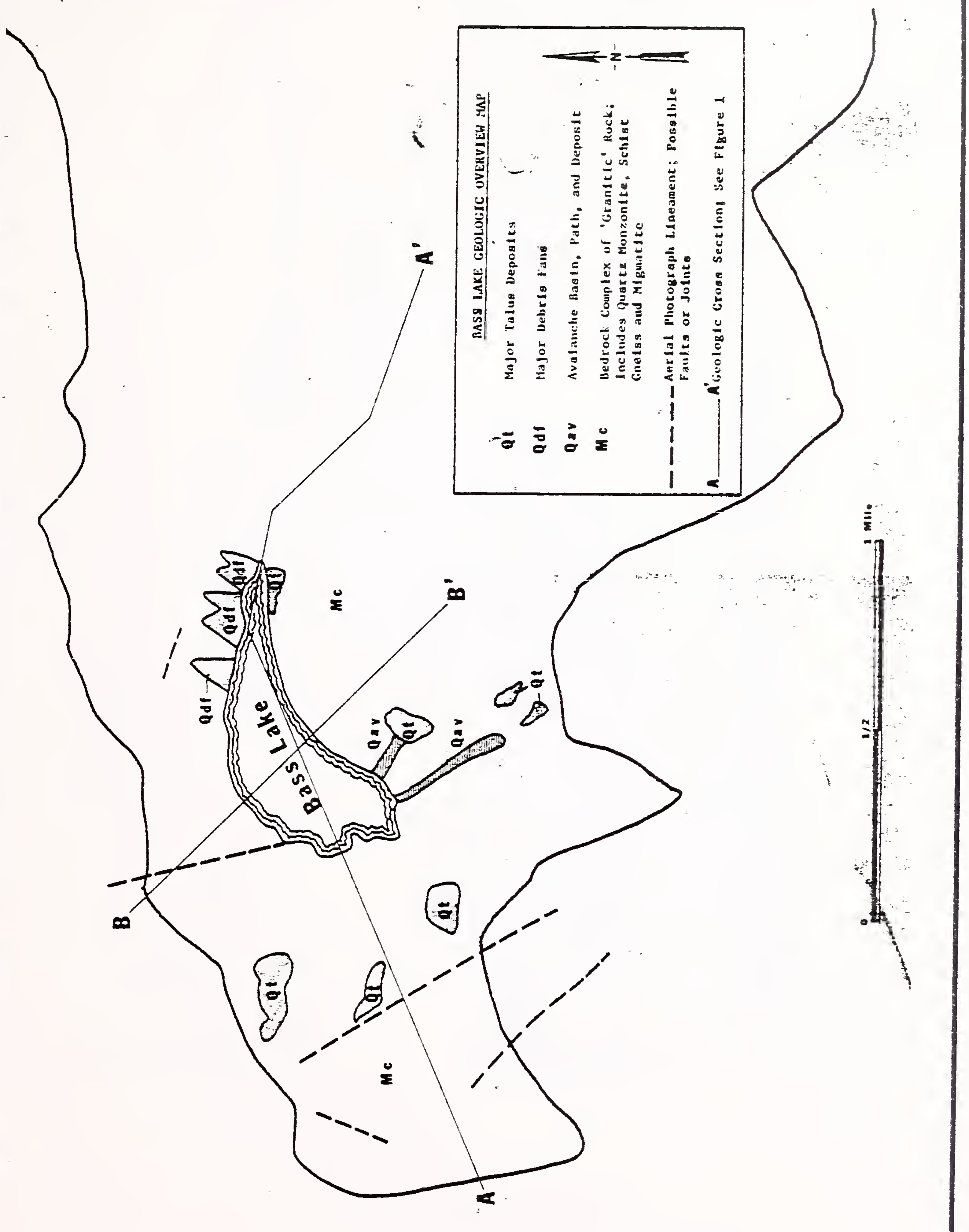
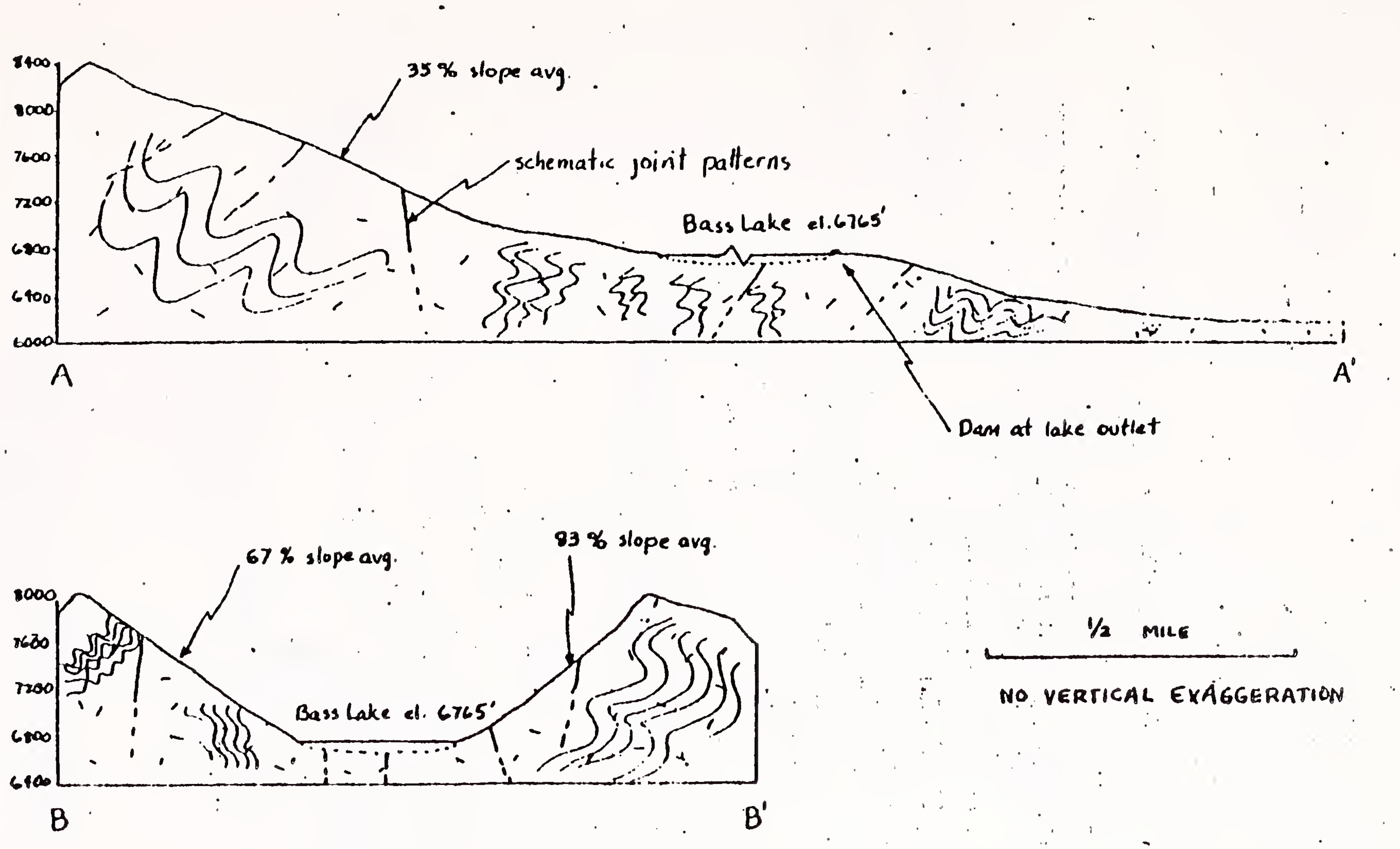

BASS LAKE GEOLOGIC OVERVIEW MAP
Qt Major Talus Deposits
Qdf Major Debris Fans
Qav Avalanche Basin, Path, and Deposit
Mc Bedrock Complex of 'Granitic' Rock; Includes Quartz Monzonite, Schist Gneiss and Migmatite
Aerial Photograph Lineament; Possible Faults or Joints
A—A' Geologic Cross Section; See Figure 1
N
Bass Lake
A
A'
B
B'
Qt
Qdf
Qav
Mc
0
1/2
1 Mile

PLATE 3

BASS LAKE DAM
GEOLOGIC SITE MAP

CH2M HILL



GEOLOGIC AND TOPOGRAPHIC CROSS SECTIONS OF BASS LAKE BASIN, BITTERROOT NATIONAL FOREST

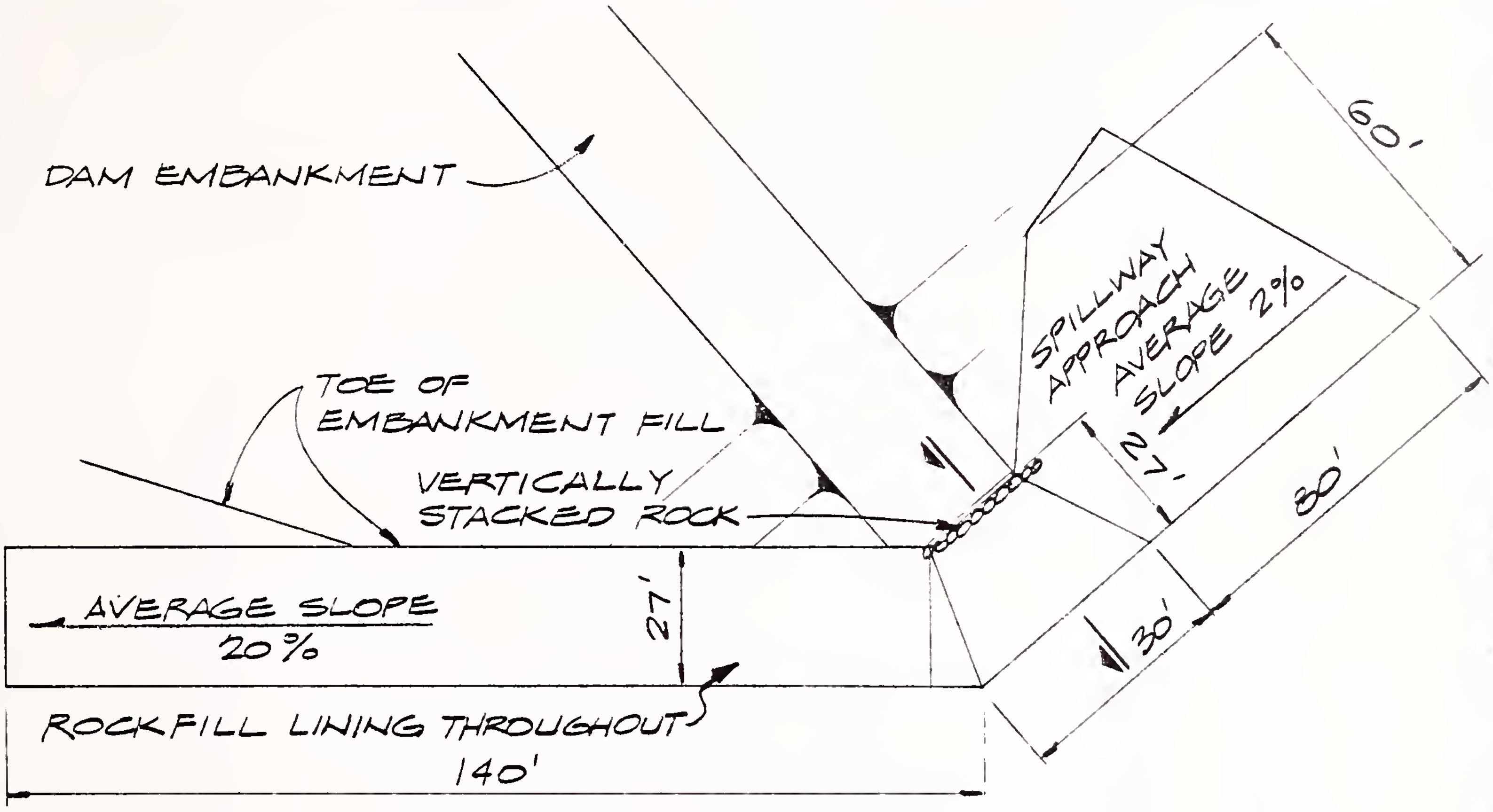
Bedrock in both cross sections is inferred to be a complex mixture of gneiss, schist, and granitic rock. See geologic map for cross section location. (pl. 1)

PLATE 4

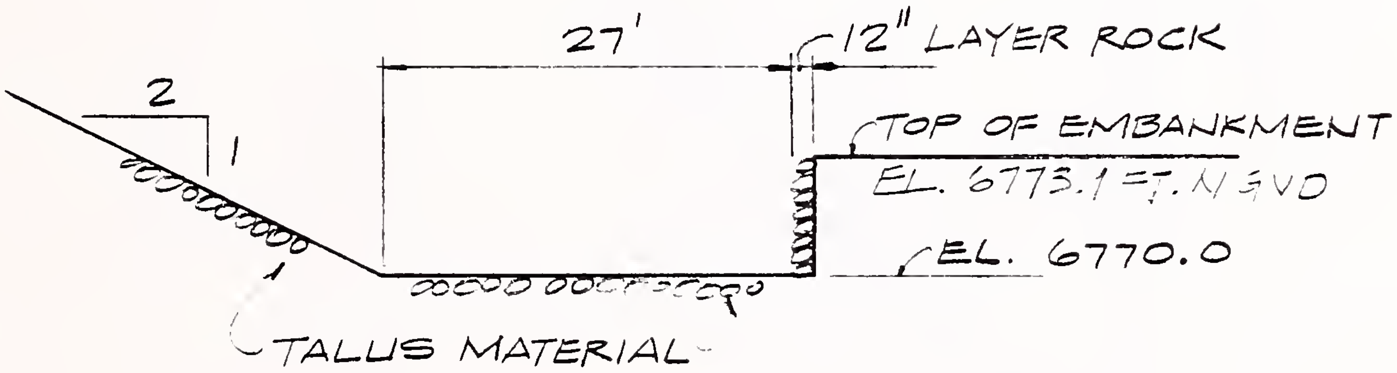
BASS LAKE DAM

GEOLOGIC SECTIONS

CH2M HILL



PLAN OF SPILLWAY
N.T.S.



SPILLWAY CREST SECTION
N.T.S.

PLATE 5

BASS LAKE DAM
SPILLWAY PLAN & SECTION

CH2M HILL

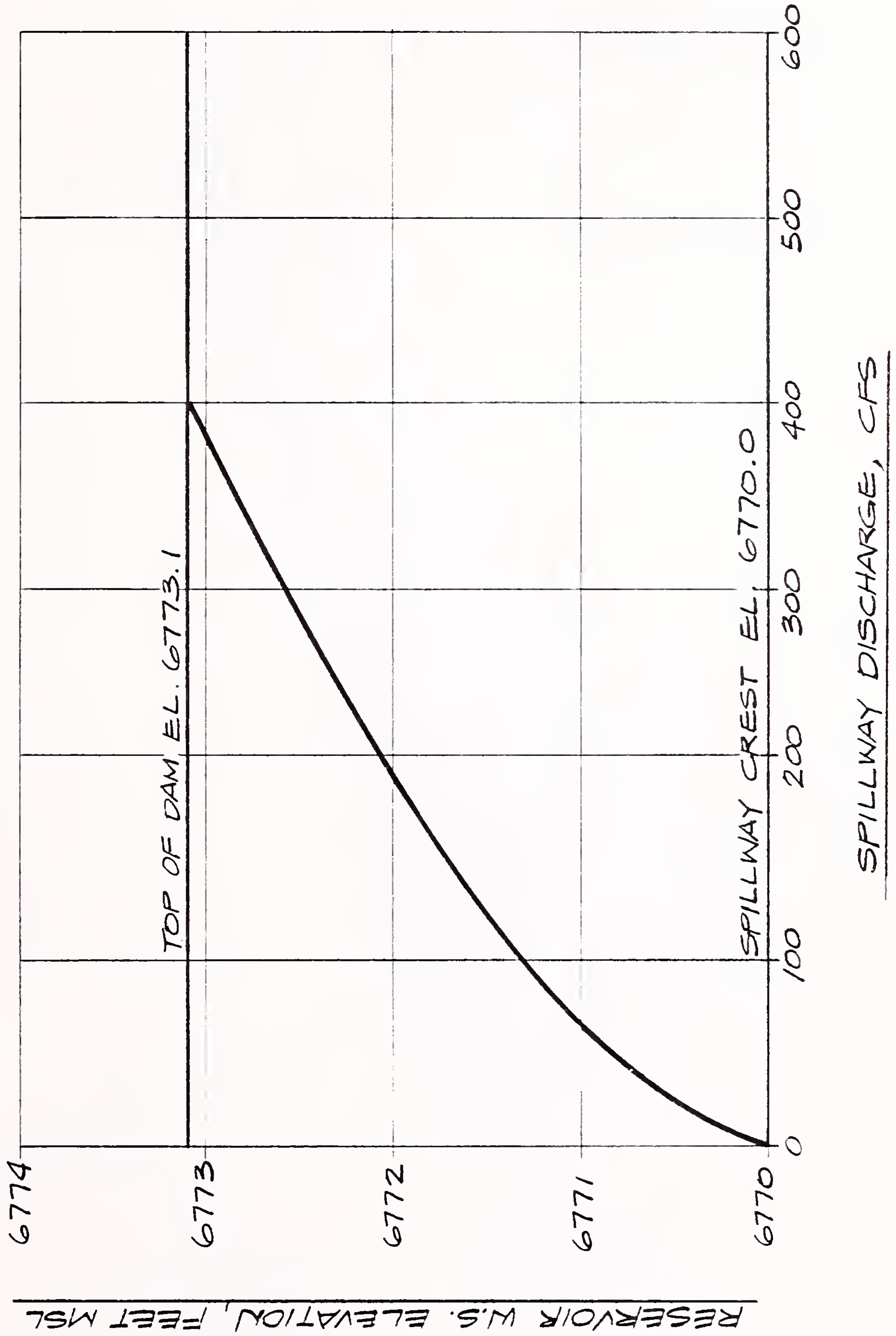


PLATE 6

BASS LAKE DAM

SPILLWAY RATING CURVE

CH2M HILL

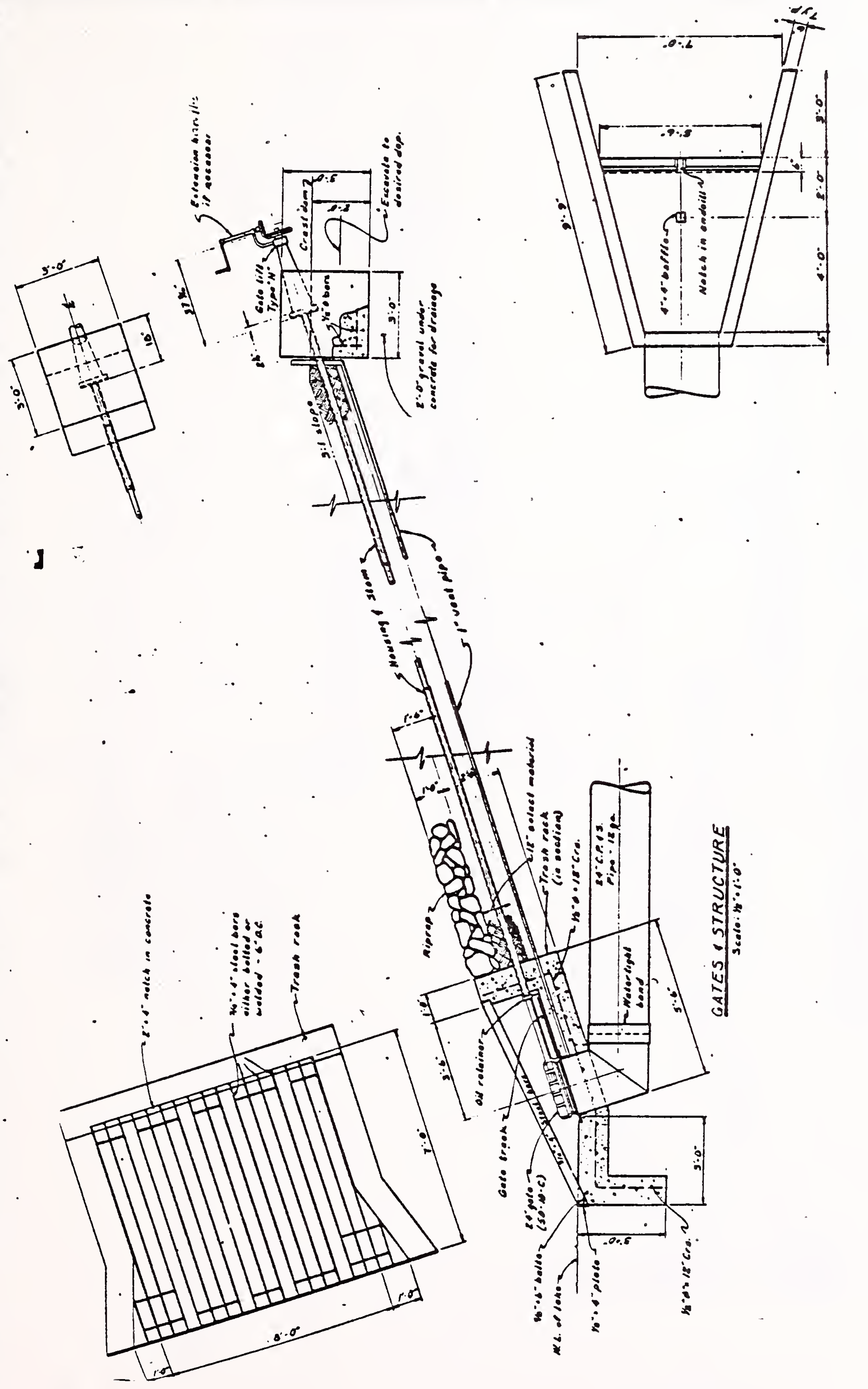
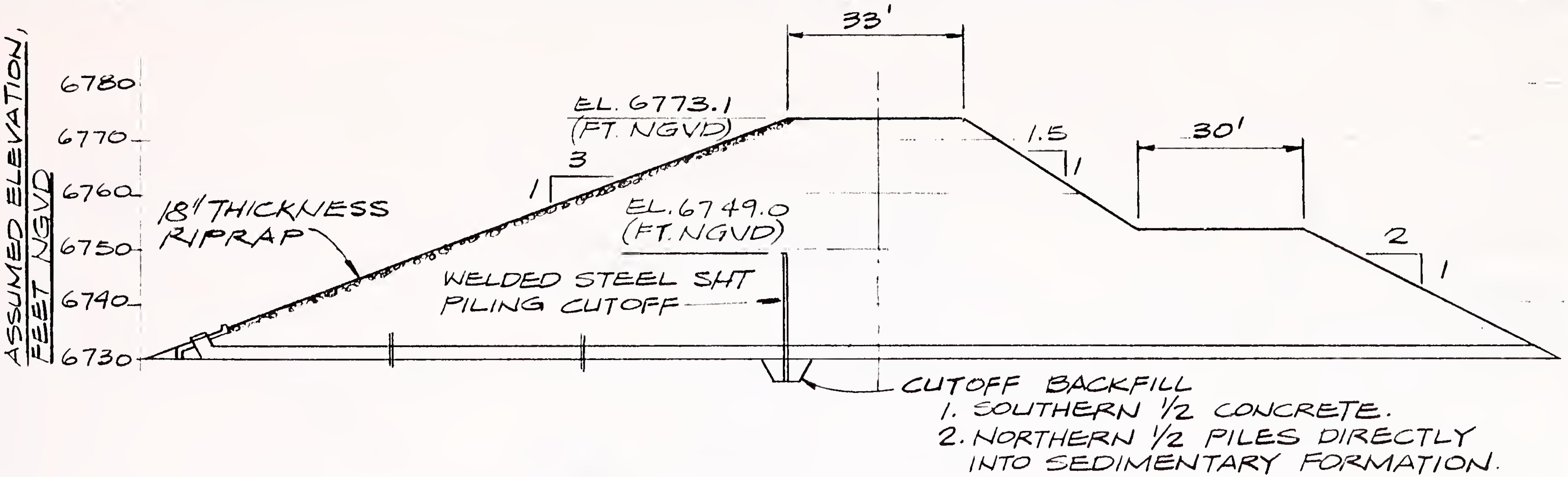


PLATE 7

BASS LAKE DAM

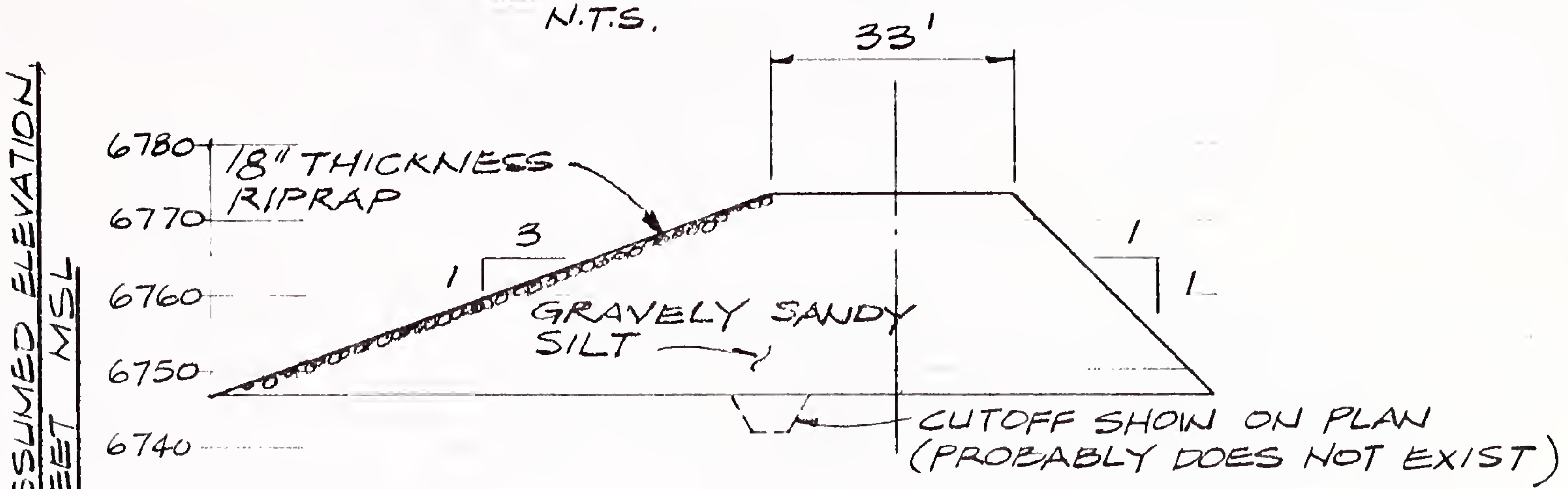
OUTLET WORKS CONTROL

CH2M HILL



TYPICAL SECTION (STA. 1+10)

N.T.S.


ASSUMED ELEVATION, FEET MSL
6780
6770
6760
6750
6740
33'
18" THICKNESS RIPRAP
3
1
1
1
GRAVELY SANDY SILT
CUTOFF SHOW ON PLAN (PROBABLY DOES NOT EXIST)

SECTION NEAR RIGHT ABUTMENT (STA. 0+00 TO 0+50)

N.T.S.

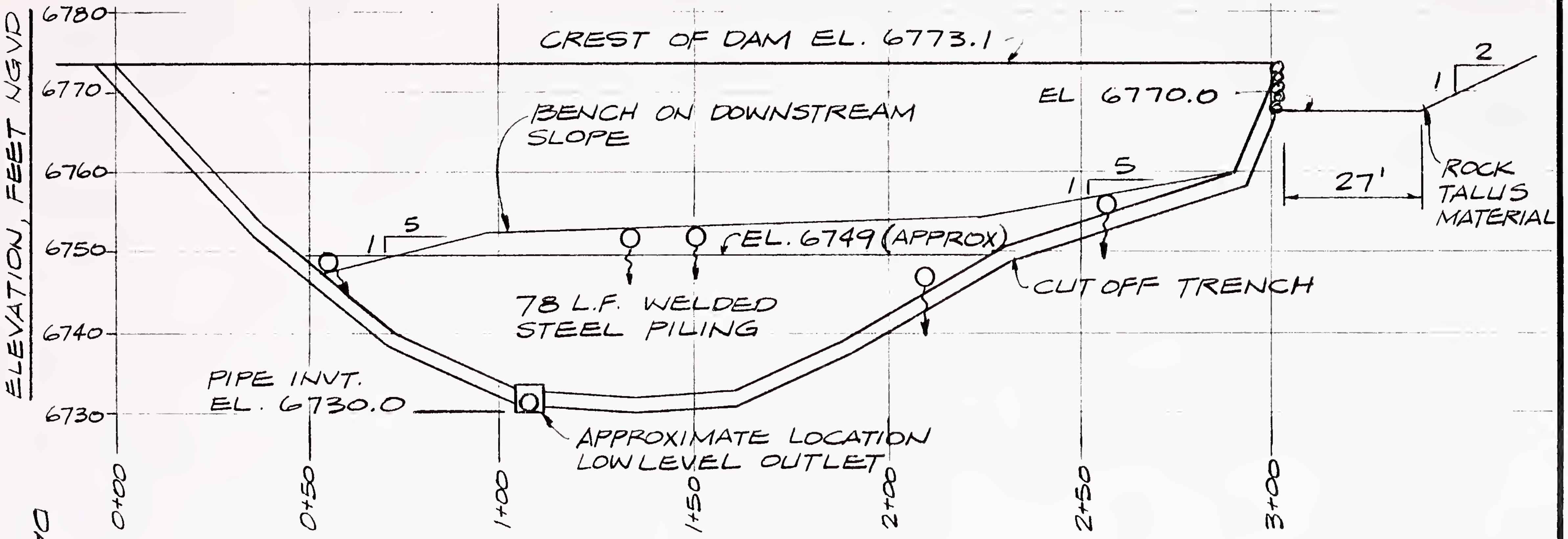
NOTE:
CUTOFF AND WELDED STEEL SHEET PILE INFORMATION TAKEN FROM U.S.D.A. FARMERS HOME ADMINISTRATION.

PLATE 8

BASS LAKE DAM

DAM EMBANKMENT SECTIONS

CH2M HILL



NOTE:

1. (Ọ) SEEPAGE ON D/S SLOPE SHOWING APPROXIMATE VISIBLE LOCATION AND MEASURED ELEVATION.
2. CUTOFF AND WELDED STEEL PILE INFORMATION TAKEN FROM U.S.D.A FARMERS HOME ADMINISTRATION.

PLATE 9

BASS LAKE DAM

DAM EMBANKMENT PROFILE

CH2M HILL